UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northwest Region
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December 21, 2000

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Re: Endangered Species Act Section 7 Biological Opinion on the Reinitiation of Consultation on Operation of the Federal Columbia River Power System, Including the Juvenile Fish Transportation Program, and 19 Bureau of Reclamation Projects in the Columbia Basin

Dear Messrs. Wright, McDonald, and Brig. General Strock:

Enclosed is the biological opinion prepared by the National Marine Fisheries Service (NMFS) pursuant to Section 7 of the Endangered Species Act (ESA) on operation of the Federal Columbia River Power System (FCRPS), Including the Juvenile Fish Transportation Program, and 19 Bureau of Reclamation Projects in the Columbia River Basin. In this biological opinion, NMFS concludes that the impacts of the FCRPS jeopardize the continued existence of listed Snake River salmon. Pursuant to Section 7 of the ESA, this biological opinion includes a reasonable and prudent alternative it believes will avoid jeopardy.

Sincerely,

Donna Darm
Acting Regional Administrator

Enclosure
cc: USFWS, Portland - Anne Badgley, Regional Director

Endangered Species Act—Section 7
Consultation

BIOLOGICAL OPINION

Reinitiation of Consultation on Operation of
the Federal Columbia River Power System,
Including the Juvenile Fish Transportation Program,
and 19 Bureau of Reclamation Projects in the Columbia Basin

Agencies: U.S. Army Corps of Engineers
Bonneville Power Administration
Bureau of Reclamation
National Marine Fisheries Service

Consultation Conducted by: National Marine Fisheries Service
Northwest Region

Dated Issued: December 21, 2000

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ACRONYMS AND ABBREVIATIONS

AFEP	anadromous fish evaluation program
AWS	auxiliary water system
BACI	before-and-after control impact
BGS	behavioral guidance structure
BIA	Bureau of Indian Affairs
BKD	bacterial kidney disease
BLM	Bureau of Land Management
BOR	Bureau of Reclamation
BPA	Bonneville Power Administration
CBFWA	Columbia Basin Fish and Wildlife Authority
CEQ	White House Council on Environmental Quality
CFD	computational fluid dynamics
CFR	Code of Federal Regulations
cfs	cubic feet per second
cm	centimeter
Corps	U.S. Army Corps of Engineers
CR	Columbia River
CREP	Conservation Reserve Enhancement Program
CRI	Cumulative Risk Initiative
CRiSP	Columbia River Salmon Passage (model)
CRITFC	Columbia River Inter-Tribal Fish Commission
CROHMS	Columbia River Operational Hydromet Management System
CTWSRO	Confederated Tribes of the Warm Springs Reservation of Oregon
CWA	Clean Water Act
CWT	coded-wire tag
D	differential delayed mortality
DGAS	dissolved gas abatement study
EDT	ecosystem diagnosis and treatment
EFH	essential fish habitat
EIS	environmental impact statement
EM	delayed mortality of nontransported fish
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESBS	extended-length submersible bar screen
ESP	extended streamflow prediction (model)
ESU	evolutionarily significant unit
FCRPS	Federal Columbia River Power System
FDA	Food and Drug Administration
FELCC	firm energy load carrying capacity
FERC	Federal Energy Regulatory Commission
ft/s	feet per second

FGE	fish guidance efficiency
FLUSH	Fish Leaving Under Several Hypotheses (model)
FPE	fish passage efficiency
FPOM	Fish Passage Operations and Maintenance Coordination Team
GBT	gas bubble trauma
GIS	geographic information system
HCP	Habitat Conservation Plan
HGMP	hatchery and genetic management plan
I-5	Interstate Highway 5
ISAB	Independent Scientific Advisory Board
ISG	Independent Scientific Group
IWUA	Idaho Water Users Association
JFT	Juvenile Fish Transportation Program
kaf	thousand acre-feet
kcfs	thousand cubic feet per second
km	kilometer
kV	kilovolt
LCR	Lower Columbia River
LCREP	Lower Columbia River Estuary Program
m	meter
m^3/s	cubic meters per second
mm	millimeter
Maf	million acre-feet
MCR	Middle Columbia River
MDEQ	Montana Department of Environmental Quality
mg/l	milligrams per liter
MGR	minimum gap runners
MOP	minimum operating pool
MOU	memorandum of understanding
msl	mean sea level
MW	megawatt
NEPA	National Environmental Policy Act
NFH	National Fish Hatcheries
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NRC	National Research Council
NWFSC	Northwest Fisheries Science Center
NWPPC	Northwest Power Planning Council
O&M	operations and maintenance
ODFW	Oregon Department of Fish and Wildlife
OWRD	Oregon Water Resources Department
PATH	Plan for Analyzing and Testing Hypotheses
PDO	Pacific Decadal Oscillation

PFMC	Pacific Fishery Management Council
PIT	passive integrated transponder
PNCA	Pacific Northwest Coordination Agreement
ppm	parts per million
PSC	Pacific Salmon Commission
PUD	Public Utility District
QA	quality assurance
QAR	quantitative analysis report
QC	quality control
Rkm	river kilometer
RM	river mile
RPA	Reasonable and Prudent Alternative
R/S	recruits per spawner
RT	radio-tracking
RSW	removable spillway weir
SAR	smolt-to-adult return rate
SIMPAS	simulated passage (model)
SOI	Southern Oscillation Index
SR	Snake River
STS	submersible traveling screen
TDG	total dissolved gas
TMDL	total maximum daily load
UCR	Upper Columbia River
UCUT	Upper Columbia United Tribes
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UWR	Upper Willamette River
VARQ	variable (VAR) outflow (Q)
VBS	vertical barrier screen
VSP	viable salmon population
WDF	Washington Department of Fisheries
WDFW	Washington Department of Fish and Wildlife
WRI	Willamette Restoration Initiative

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1.0 OBJECTIVES

The Endangered Species Act (ESA) (16 USC 1531-1544), amended in 1988, establishes a national program for the conservation of threatened and endangered species of fish, wildlife, and plants and the habitat on which they depend. Section 7(a)(2) of the ESA requires Federal agencies to consult with USFWS and NMFS, as appropriate, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or to adversely modify or destroy their designated critical habitats.

This document is the product of an interagency consultation pursuant to Section 7(a)(2) of the ESA and implementing regulations found at 50 Code of Federal Regulations (CFR) Part 402. It consists of four actions:

- The Federal agencies that operate, or market power from, the Federal Columbia River Power System (FCRPS), namely the Bonneville Power Administration (BPA), the U.S. Army Corps of Engineers (Corps), and the U.S. Bureau of Reclamation (BOR) (collectively the "Action Agencies"), reinitiated consultation with the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) to consider the effects of actions related to FCRPS configuration, operations, and maintenance on species listed as threatened or endangered under the ESA.

- BOR is also consulting on the continued operation and maintenance of 19 of its projects in the Columbia River basin (Table 1.0-1).[1] Two of those projects, the Columbia Basin Project and the Hungry Horse Project, include facilities that are also part of the FCRPS. Several of the remaining 17 BOR-owned projects in the basin include power plants and/or provide flood control benefits, but these power plants (and their associated dams and reservoirs) are not operated or coordinated as part of the FCRPS, nor do these project facilities provide system flood control. All 19 BOR projects are authorized to provide water for irrigated agriculture, and all except the Hungry Horse Project do so at present. While the configuration, operation, and maintenance of the FCRPS and the operation and maintenance of the BOR's 19 projects are separate agency actions, they are similar in that all have hydrologic effects on the flows in the mainstems of the Columbia and Snake rivers. However, this biological opinion does not attempt to apportion the

[1]Because of ongoing negotiations in a general adjudication of water rights under way in Idaho, BOR could not adequately define its proposed action to facilitate consultation for its 11 irrigation projects in the Snake River basin. Since discussions are continuing, BOR has indicated that the proposed action may be different from those measures set forth in its December 21, 1999, biological assessment. Accordingly, BOR has asked to extend the consultation on these 11 projects pending a revised proposed action and analysis of effects (see BOR 2000d). NMFS has agreed to extend the current consultation with regard to BOR's projects in the Snake River basin and to exclude those projects from this biological opinion. BOR anticipates providing the necessary additional information, and NMFS anticipates issuing a supplemental biological opinion on these projects before water from these projects is needed for irrigation use in the 2001 growing season.

Table 1.0-1. BOR irrigation projects in Columbia River basin.

Project	Location	Subbasin or Stream
Upper Columbia River (Upstream of Snake River Confluence)		
Hungry Horse	Western Montana, north of Flathead Lake	South Fork Flat Head River
Bitter Root	Western Montana, south of Missoula	Bitterroot River
Missoula Valley	Western Montana, north of Missoula	Clark Fork River
Frenchtown	Western Montana, north of Missoula	Clark Fork River
Dalton Gardens	North Idaho, north of Coeur d'Alene	Spokane (Hayden Lake)
Avondale	North Idaho, north of Coeur d'Alene	Spokane (ground water)
Rathdrum Prairie	North Idaho, northwest of Coeur d'Alene	Spokane (ground water)
Spokane Valley	Eastern Washington, east of Spokane	Spokane (ground water)
Columbia Basin	Central Washington	Columbia River
Chief Joseph[1]	North-central Washington, from Canadian border to Wenatchee	Okanogan and Columbia rivers
Okanogan	North-central Washington, near Okanogan	Okanogan River
Yakima	Central Washington, near Yakima	Yakima River
Lower Columbia (Downstream of Snake River Confluence)		
Umatilla	Northeast Oregon	Umatilla and Columbia rivers
Crescent Lake Dam	Central Oregon west of Bend	Deschutes River
Crooked River	Central Oregon, north of Bend	Crooked River
Deschutes	Central Oregon, north of Bend	Deschutes River
Wapinitia	North-central Oregon, south of The Dalles	Deschutes River
The Dalles[1]	North-central Oregon, near The Dalles	Columbia River
Tualatin	Northwest Oregon, west of Portland	Tualatin River (Willamette River)
Snake River		
Minidoka	Southern Idaho and western Wyoming from Twin Falls Idaho to Jackson Lake, Wyoming	Snake River
Palisades	Eastern Idaho, on Wyoming border	Snake River
Michaud Flats	Southern Idaho, near Pocatello	Snake River
Little Wood River	South-central Idaho, north of Twin Falls	Little Wood River
Boise	Southwest Idaho, near Boise	Boise and Payette rivers
Mann Creek	Southwest Idaho, northwest of Boise	Weiser River
Owyhee	Eastern Oregon and southwest Idaho, near Ontario, Oregon	Owyhee and Snake rivers
Vale	Eastern Oregon, west of Ontario	Malheur River
Burnt River	Eastern Oregon, south of Baker City	Burnt River
Baker	Eastern Oregon, near Baker City	Powder River
Lewiston Orchards	West-central Idaho, near Lewiston	Clearwater River

Note: Shaded (Snake River) areas are not included in this biological opinion. The Arnold Project in central Oregon was also removed from this biological opinion based on comments from BOR that this is not a Federal project and was erroneously included in its biological assessment.
[1]Chief Joseph Dam and The Dalles Dam are owned and operated by the Corps, but have associated irrigation works that are owned and operated by BOR.

relative contribution of the FCRPS and BOR projects to the current status of the evolutionarily significant units (ESUs).[2]

- NMFS is also consulting internally on its issuance of a Section 10 permit for the Corps' Juvenile Fish Transportation Program (JFT). The FCRPS operation necessarily includes the JFT, which requires an enhancement permit issued by NMFS pursuant to ESA Section 10(a)(1)(A).

- NMFS is also consulting internally on its issuance of Section 10 permits for certain of the research, monitoring, and evaluation actions essential to the implementation of this biological opinion. Not all are included, because not all are sufficiently defined to identify the proposed methodologies and, from that, the estimated levels of take. As additional studies and study plans are developed in accordance with this biological opinion, NMFS anticipates the need for additional Section 10 research permits and additional review of the issuance of those permits under Section 7(a)(2).

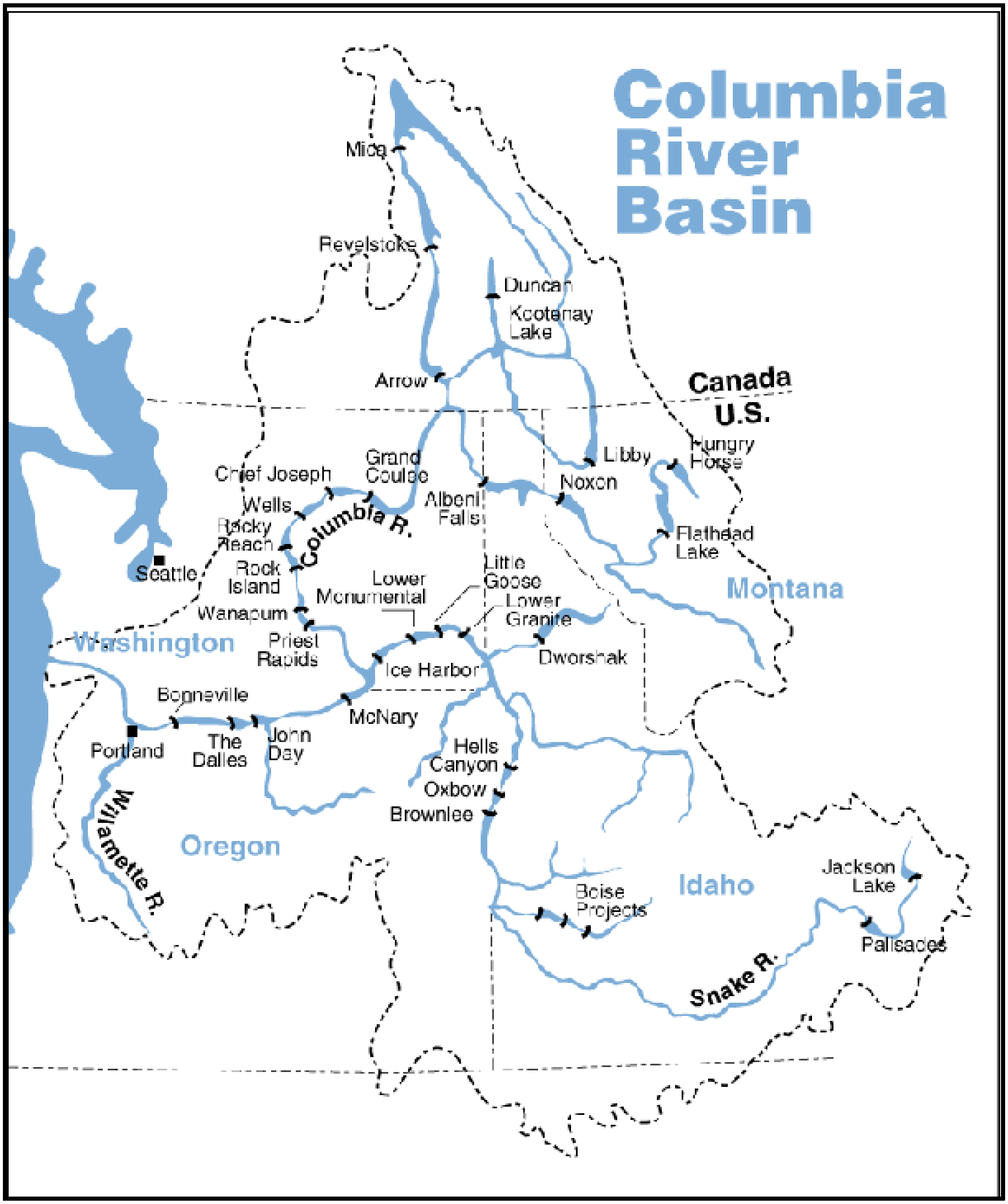
The action area encompasses the mainstem Columbia and Snake rivers from Chief Joseph Dam and Hells Canyon Dam down to and including the estuary and plume (nearshore ocean) of the Columbia River (Figure 1-1). With respect to the FCRPS projects, this biological opinion considers the effects of the existing configuration, continued operation, and maintenance of the 14 sets of dams, powerhouses, and associated reservoirs known collectively as the FCRPS and operated as a coordinated system for purposes of power production and flood control on behalf of the Federal government. The facilities that constitute the FCRPS are Dworshak, Lower Granite, Little Goose, Lower Monumental, and Ice Harbor dams, powerplants, and reservoirs in the Snake River basin; Albeni Falls, Hungry Horse, Libby, Grand Coulee, Banks Lake (features of the Columbia Basin Project), and Chief Joseph dams, powerplants, and reservoirs in the upper Columbia River basin; and McNary, John Day, The Dalles, and Bonneville dams, powerplants, and reservoirs in the lower Columbia River basin. Some of these dams and reservoirs are also operated for other purposes as authorized by Congress (e.g., navigation, irrigation, fish and wildlife, and recreation). These operations are inseparable from those for power generation and flood control. They are included in the scope of this consultation, except where activities are separate Federal actions under other authorities (e.g., Clean Water Act [CWA] Section 404).

With respect to the 19 BOR projects, formal consultation on the full scope of these proposed operations is being accomplished as follows:

1. This biological opinion considers the aggregate effects of all 19 BOR projects on streamflows in the mainstem Columbia and Snake rivers (these effects result from

[2]Throughout this biological opinion, NMFS uses ESU to define anadromous salmon and steelhead populations either listed or being considered for listing under the ESA. An ESU is a population that 1) is substantially isolated reproductively from conspecific populations, and 2) represents an important component of the evolutionary legacy of the species. The term ESU may include portions or combinations of more commonly used definitions of stocks within or across regions.

Figure 1-1. Map of the Columbia River basin, including major facilities that make up the Federal Columbia River Power System.



reservoir storage and releases, diversions and withdrawals, consumptive uses, and return flows). It also considers the effects of using some of these projects and other sources to provide instream flow in the Columbia River downstream of Chief Joseph Dam. Effects considered include the frequency of attainment of the flow objectives established in the 1995 FCRPS Biological Opinion[3] and 1998 Supplemental FCRPS Biological Opinion.[4]

2. This biological opinion also considers all the known operational effects of the BOR projects upstream of Chief Joseph Dam. The only known effects of these projects on listed salmon and steelhead result from the cumulative hydrologic effects of their operations on streamflows in the Columbia River downstream of Chief Joseph Dam.

3. BOR is also consulting on any additional effects of its projects located downstream of Chief Joseph Dam in the Columbia River Basin, except for the Columbia Basin Project. BOR has already prepared biological assessments, or, as appropriate, is preparing supplemental biological assessments to address any additional effects of such projects, such as effects on tributary habitat, tributary water quality, or direct effects on salmon survival (impingement, entrainment in diversions, false attraction to return flows), through project-specific consultations designed to supplement this biological opinion. Because mainstem flows are addressed in this biological opinion, these supplemental consultations will address effects of mainstem flows only to the extent to which consultation reveals additional effects on the mainstem flow regime that are not considered in this 2000 FCRPS Biological Opinion. The schedule for these supplemental consultations is undetermined at this time pending receipt of additional information from BOR.

4. The Columbia Basin Project, features of which are located both upstream and downstream of Chief Joseph Dam, diverts water from and returns it to the mainstem Columbia River above McNary Dam (with most of the project water diverted from the Columbia River above Chief Joseph Dam, but all return flows occurring below Chief Joseph Dam). Its storage and diversion operations are integral to the operation of Grand Coulee Dam. All the project's effects on listed salmon and steelhead occur in the mainstem. For these reasons, the BOR initiated consultation specifically on the operation and maintenance of all the Federally owned lands and facilities of the project (whether such operation and maintenance is performed by BOR or by others pursuant to agreements with BOR). This 2000 FCRPS Biological Opinion, therefore, considers all the known operational effects of the Columbia Basin Project, not just its contribution to cumulative hydrologic impacts on streamflows in the Columbia River, even though some

[3] "Biological Opinion—Reinitiation of Consultation on 1994–1998 Operation of the Federal Columbia River Power System and Juvenile Transportation Program in 1995 and Future Years" (NMFS 1995a).

[4] "Supplemental Biological Opinion—Operation of the Federal Columbia River Power System Including the Smolt Monitoring Program and the Juvenile Fish Transportation Program: A Supplemental to the Biological Opinion Signed on March 2, 1995" (NMFS 1998).

of the project's features are downstream of Chief Joseph Dam in the Columbia River basin.

This consultation considers whether the effects of these actions are likely to jeopardize the continued existence of 12 listed species of Columbia Basin Project salmonids and cause the destruction or adverse modification of their designated critical habitat. The 12 species are as follows:

- Snake River (SR) spring/summer chinook salmon (*Oncorhynchus tshawytscha*; listed as threatened on April 22, 1992 [57 FR 14653]); critical habitat designated on December 28, 1993 [58 FR 68543], and revised on October 25, 1999 [64 FR 57399]

- Snake River (SR) fall chinook salmon (*O. tshawytscha*; listed as threatened on April 22, 1992 [57 FR 14653]); critical habitat designated on December 28, 1993 [58 FR 68543]

- Upper Columbia River (UCR) spring chinook salmon (*O. tshawytscha*; listed as endangered on March 24, 1999 [64 FR 14308]); critical habitat designated on February 16, 2000 [65 FR 7764]

- Upper Willamette River (UWR) chinook salmon (*O. tshawytscha*; listed as threatened on March 24, 1999 [64 FR 14308]); critical habitat designated on February 16, 2000 [65 FR 7764]

- Lower Columbia River (LCR) chinook salmon (*O. tshawytscha*; listed as threatened on March 24, 1999 [64 FR 14308]); critical habitat designated on February 16, 2000 [65 FR 7764]

- Snake River (SR) steelhead (*O. mykiss*; listed as threatened on August 18, 1997 ([62 FR 43937]); critical habitat designated on February 16, 2000 [65 FR 7764]

- Upper Columbia River (UCR) steelhead (*O. mykiss*; listed as endangered on August 18, 1997 [62 FR 43937]); critical habitat designated on February 16, 2000 [65 FR 7764]

- Middle Columbia River (MCR) steelhead (*O. mykiss*; listed as threatened on March 25, 1999 [64 FR 14517]); critical habitat designated on February 16, 2000 [65 FR 7764]

- Upper Willamette River (UWR) steelhead (*O. mykiss*; listed as threatened on March 25, 1999 [64 FR 14517]); critical habitat designated on February 16, 2000 [65 FR 7764]

- Lower Columbia River (LCR) steelhead (*O. mykiss*; listed as threatened on March 19, 1998 [63 FR 13347]); critical habitat designated on February 16, 2000 [65 FR 7764]

- Columbia River (CR) chum salmon (*O. keta*; listed as threatened on March 25, 1999 [64 FR 14508]); critical habitat designated on February 16, 2000 [65 FR 7764]

- Snake River (SR) sockeye salmon (*O. nerka*; listed as endangered on November 20, 1991 [56 FR 58619]); critical habitat designated on December 28, 1993 [58 FR 68543]

1.1 RELATION TO OTHER BIOLOGICAL OPINIONS

This 2000 FCRPS Biological Opinion supersedes all previous opinions NMFS has issued concerning the FCRPS. This includes the 1995 FCRPS Biological Opinion and the supplemental opinions NMFS issued on May 14, 1998, December 9, 1999, and February 4, 2000. Further, NMFS and USFWS have coordinated this multispecies opinion and the opinion USFWS is issuing on the effects of hydrosystem operations on Columbia River basin species within its jurisdiction, dated December 2000. The two agencies intend the recommendations and requirements of these opinions to be mutually consistent. They represent the Federal biological resource agencies' recommendations of measures that are most likely to ensure the survival and recovery of all listed species and that are within the current authorities of the Action Agencies.

1.2 SECTION 10 PERMITS

1.2.1 Section 10 Permits for Juvenile Transportation Program

In 1999, the Corps Walla Walla District applied to NMFS for a new Section 10 permit for the JFT. As an interim measure, NMFS extended the Corps' existing Permit 895, under authority of Section 10 of the ESA and NMFS' regulations governing ESA-listed fish and wildlife permits (50 CFR Parts 217 through 227), to be valid until December 31, 2000, or until replaced by the new permit. The extension allows the duration of Permit 895 to coincide with the completion of this reinitiation of ESA Section 7 consultation on the long-term management strategy for the FCRPS. Permit 895 authorizes the Corps' annual direct takes of the following listed fish: juvenile endangered SR sockeye salmon and juvenile, threatened, naturally produced, and artificially propagated SR spring/summer chinook salmon, SR fall chinook salmon, and SR steelhead. This take is authorized for the Corps' JFT at four hydroelectric projects on the Snake and Columbia rivers (Lower Granite, Little Goose, Lower Monumental, and McNary dams). Permit 895 also authorizes the Corps' annual incidental takes of ESA-listed adult fish associated with fallbacks through the juvenile fish bypass systems at the four dams.

With regard to three other ESUs (UCR spring chinook salmon, UCR steelhead, and MCR steelhead), NMFS has determined that any take of these species associated with the Corps' transportation activities would be incidental to operation of the juvenile bypass system under the existing requirement to suspend transportation operations at McNary Dam during the spring migration period. NMFS' estimates of incidental take for each of these ESUs is described in the incidental take statement in Section 10 of this document. Any direct take of UCR spring chinook salmon, UCR steelhead, and MCR steelhead for the purposes of the planned transport experiment from McNary Dam will be addressed in a separate ESA Section 10 permit.

In addition, Permit 895 does not cover direct take of the following lower Columbia River ESUs: UWR chinook salmon, UWR steelhead, LCR chinook salmon, LCR steelhead, and CR chum salmon. The juveniles from all of the spawning populations in these ESUs enter the Columbia River at points below McNary Dam. Thus, they are not subject to either direct or incidental take associated with the Corps' transportation program.

1.2.2 Section 10 Permits for Research and Monitoring

Scientific research and monitoring are critical parts of the overall program to minimize take of ESA-listed anadromous fish species resulting from the operation of mainstem FCRPS projects on the Columbia and Snake rivers. These activities are necessary to satisfy the Action Agencies' responsibility for minimizing take and for ensuring that jeopardy standards will be met. While some research/monitoring activities cannot be identified in enough detail at this time to allow NMFS to estimate incidental take, others can be anticipated now. Appendix H to this biological opinion provides estimates of incidental take for each of the 12 listed ESUs for the latter group of studies.

1.3 APPLICATION OF ESA SECTION 7(A)(2) STANDARDS–JEOPARDY ANALYSIS FRAMEWORK

To achieve the objectives of this biological opinion, NMFS uses the five-step approach for applying the ESA Section 7(a)(2) standards developed in the 1995 FCRPS Biological Opinion to Pacific salmon. The steps are as follows:

1. Define the biological requirements and current status of each listed species (Section 4).

2. Evaluate the relevance of the environmental baseline to the species' current status (Section 5).

3. Determine the effects of the proposed or continuing action on listed species (methods described in Section 6.1 and applied in Sections 6.2 and 6.3).

4. Determine whether the species can be expected to survive with an adequate potential for recovery under the effects of the proposed or continuing action, the effects of the environmental baseline, and any cumulative effects, and considering measures for survival and recovery specific to other life stages (Section 8).

5. Identify reasonable and prudent alternatives (RPAs) to a proposed or continuing action when that action is likely to jeopardize the continued existence of a listed species or destroy or adversely modify its critical habitat (Section 9). Thus, this step is relevant

only when the conclusion of the previously described analysis is that the proposed action would jeopardize listed species. The RPA will have to both reduce the mortality associated with the proposed action to a level that does not jeopardize the species, and maintain (or restore) essential habitat features so that there is no adverse modification of designated critical habitat. An analysis to determine the sufficiency of the reasonable and prudent alternative will be based on the same considerations described above.

As discussed in the 1995 FCRPS Biological Opinion, the fourth step of the application framework called for a two-part analysis. The first part focuses on the action area, delineated as the geographic extent of direct and indirect effects of the action (50 CFR Section 402.02). The effects of the action, the effects of the environmental baseline, and the cumulative effects in the action area are considered together relative to the action area biological requirements of the various listed species. The essential features of critical habitat guide in this part of the analysis.

The second part of the analysis places the action area investigation in the context of the full salmon life cycle, considering each ESU's species-level biological requirements (NMFS 1995a, pp. 13-14).

> This comprehensive analysis is necessary to fully evaluate the significance of each action under consultation to the biological requirements of the listed species in all life stages. The NMFS looks beyond the particular action area for this analysis to consider measures likely to be necessary in all life stages that, in combination, would insure that the biological requirements of the listed species will be met and thereby insure its continued existence.

For the purpose of this second part of Step 4 of the ESA Section 7 framework, to assess the effects of proposed actions while listed ESUs move toward recovery, NMFS defined the degree to which species-level biological requirements must be met (NMFS 1995a, p. 14):

> At the species level, NMFS considers that the biological requirements for survival, with an adequate potential for recovery, are met when there is a high likelihood that the species' population will remain above critical escapement thresholds over a sufficiently long period of time. Additionally, the species must have a moderate to high likelihood that its population will achieve its recovery level within an adequate period of time. The particular thresholds, recovery levels, and time periods must be selected depending upon the characteristics and circumstances of each salmon species under consultation.

Pursuant to the ESA, to fully consider the current status of the listed species (50 CFR Section 402.14(g)(2)), NMFS evaluates the species-level biological requirements of a species, subspecies, or distinct population segment level. For Pacific salmonids, NMFS evaluates species-level biological requirements as they relate to ESUs. Since 1995, NMFS has developed the viable salmonid population (VSP) concept as a tool to evaluate whether the species-level requirements of ESUs are being met (McElhany et al. 2000). Each salmonid ESU may contain multiple independent populations. VSPs are independent populations that have a negligible risk of extinction due to threats from demographic variation (random or directional), local environmental variation, and genetic diversity changes (random or directional) over 100 years.

The attributes associated with VSPs include adequate abundance, productivity (population growth rate), population spatial scale, and diversity. These attributes are influenced by survival, behavior, and experiences throughout the entire life cycle and are, therefore, distinguished from the more specific biological requirements associated with the action area (described in Section 5) and the particular action under consultation. Species-level biological requirements are influenced by *all* actions affecting the species throughout its life cycle and may be broader than the requirements of any specific independent population in the ESU. The action-area effects must be reviewed in the context of these species-level biological requirements to evaluate the potential for survival and recovery, relevant to the status of the species, given the comprehensive set of human activities and environmental conditions affecting the species.

Although the 1995 narrative standard, quoted above, defined the direct measurement of species-level biological requirements in terms of abundance, this definition also implicitly addresses the productivity criterion for VSPs. Given the current low abundance levels, the population growth rate must increase to reach the critical threshold or recovery abundance levels. In the long term, the population growth rate must remain high enough to maintain a stable return rate and keep populations at acceptable abundance levels. Although application of VSP by a technical recovery team may in the future suggest measurements of spatial scale and diversity, this biological opinion considers biological requirements primarily in terms of abundance and productivity.

For ESUs with multiple populations, the spatial scale and diversity criteria for VSPs are addressed primarily by specifying the number of populations that must meet species-level biological requirements, as defined above. This is considered on an ESU-by-ESU basis. The degree to which independent populations in an ESU have been delineated, and their relation to each other, can be relevant to an ESA Section 7 decision. Particularly important is the state of knowledge regarding the degree to which a mixture of independent populations in an ESU is required for the ESU to survive in the face of catastrophic events and long-term demographic processes and to maintain long-term evolutionary potential (McElhany et al. 2000). To the extent possible, jeopardy determinations should be based on evaluation of available information to determine if identified breeding units represent independent populations, as defined by McElhany et al. (2000). However, biological populations have not yet been defined for most ESUs considered in this opinion. In the case of the SR spring/summer chinook ESU, NMFS determined in the 1995 FCRPS Biological Opinion that the relevant measure is “at least 80% of the available ‘index stocks.’” NMFS’ proposed recovery plan for Snake River salmon (NMFS 1995c) also described “80% of available index stocks” as the percent required to meet specified abundance levels for delisting. For all other ESUs, all currently defined populations should be maintained to ensure adequate genetic and life history diversity, as well as the spatial distribution of populations within each ESU.

Step 4 of the application framework ultimately requires that NMFS determine whether the species-level biological requirements can be met considering the significance of the effects of the action under consultation. Recovery planning can provide the best guidance for making this determination. The 1995 FCRPS Biological Opinion stated:

> Recovery plans for listed salmon call for measures in each life stage that are based upon the best available scientific information concerning the listed species' biological requirements for survival and recovery. As the statutory goal of the recovery plan is for the species' conservation and survival it necessarily must add these life-stage specific measures together to result in the survival of the species, at least, and its recovery and delisting at most. For this reason, the Recovery Plan is the best source for measures and requirements necessary in each life stage to meet the biological requirements of the species across its life cycle (p. 14).

Recovery planning will identify the feasible measures that are needed in each stage of the salmonid life cycle for conservation and survival within a reasonable time. Measures are feasible if they are expected both to be implemented and to result in the required biological benefit. A time period for recovery is reasonable depending on the time requirements for implementation of the measures and the confidence in the survival of the species while the plan is implemented. The plan must demonstrate the feasibility of its measures, the reasonableness of its time requirements, and how the elements are likely to achieve the conservation and survival of the listed species based on the best science available.

NMFS intends that it and the other Action Agencies will, as portions of recovery plans become final, incorporate applicable elements into their review and annual plans for the FCRPS described in this biological opinion. If the incorporation of such recovery plan elements could entail major changes in analyses or actions, the Action Agencies may reinitiate consultation with NMFS, and may need to undertake additional analyses to satisfy the National Environmental Policy Act (NEPA) and other requirements.

In 1995, NMFS relied on the proposed Snake River salmon recovery plan, issued in draft in March 1995. Since 1995, the number of listed salmonid species has gone from three to 12, and the need for recovery planning for Columbia basin salmonids has quadrupled. Rather than finalize the 1995 proposed recovery plan, NMFS has developed guidelines for basin-level, multispecies recovery planning on which individual, species-specific recovery plans can be founded. "Basin-level" encompasses habitat, harvest, hatcheries, and hydro. This recovery planning analysis is contained in the document entitled "Conservation of Columbia Basin Fish: Final Basinwide Salmon Recovery Strategy" (hereafter, the Basinwide Recovery Strategy [Federal Caucus 2000]). The Basinwide Recovery Strategy replaces the 1995 proposed recovery plan for Snake River stocks until a specific plan for those stocks is developed on the basis of the Basinwide Recovery Strategy. Recovery plans for each individually listed species will provide the particular statutorily required elements of recovery goals, criteria, management actions, and time estimates that are not developed in the Basinwide Recovery Strategy.

Until the species-specific recovery plans are developed, the Basinwide Recovery Strategy provides the best guidance for judging the significance of an individual action relative to the species-level biological requirements. In the absence of completed recovery planning, NMFS strives to ascribe the appropriate significance to actions to the extent available information allows. Where information is not available on the recovery needs of the species, either through recovery planning or otherwise, NMFS applies a conservative substitute that is likely to exceed what would be expected of an action if information were available.

1.3.1 Section 7(a)(2) Jeopardy Analysis Framework Applied to FCRPS

In this section, NMFS discusses the application of the statutory requirements of ESA Section 7(a)(2) to the actions considered in this consultation. Whereas the statutory standards, and the regulations that interpret them, are the ultimate determinants for this biological opinion, it has been necessary for NMFS to develop a methodology for applying those standards that uses the best scientific and commercial data available. These methods and the available science are best applied through reference to particular indicators of the essential elements of the Section 7(a)(2) standards, the likelihoods of survival and recovery.

1.3.1.1 Jeopardy Standard

Consistent with Step 4 of the Jeopardy Analysis Framework, discussed above, the mortality of listed salmonids in the different ESUs that can be attributed to the action must be below the following:

- A level that, when combined with mortality occurring in other life stages, results in a high likelihood of survival and a moderate to high likelihood of recovery

In the application of this standard, NMFS relies on all the best available scientific information. For some ESUs, this involves a great deal of modeling analysis, including simple determinative models of passage survival, the Cumulative Risk Initiative (CRI) analysis of population status, and the incorporation of both into analyses to assess the effects of alternative operations on survival from one generation to the next. For purposes of this analysis, NMFS determined that there was enough information to quantify species status and incremental survival changes resulting from actions affecting hydrosystem passage survival for 11 of the 12 ESUs. The estimates also took into account harvest levels and the Mid-Columbia Habitat Conservation Plan as provided for in the basinwide strategy (see Appendix A). Impacts of hydrosystem effects on spawning and rearing success, as well as hatchery and habitat actions affecting other life stages, were evaluated qualitatively for these 11 ESUs. The analysis for SR sockeye salmon was entirely qualitative. There is still substantial uncertainty in the resulting NMFS' projections of the likelihood of survival and recovery. As a result, NMFS relies on this analysis primarily to provide a standardized measure of risk against which to judge the significance of the action to the continued existence of the ESU. In the end, however, NMFS' determination of consistency with

ESA Section 7(a)(2) is qualitative, informed to the extent possible by standardized quantitative analysis.

1.3.1.2 Metrics and Criteria Useful for Assessing Jeopardy Standards for FCRPS

As noted above, NMFS has determined, for the purposes of this biological opinion, that there is enough information to quantitatively evaluate the likelihood of survival and recovery for 11 of the 12 ESUs. This section describes a number of metrics integral to that analysis.

1.3.1.2.1 Metrics Indicative of Survival. For the survival component of the jeopardy standard, a measurement of the risk of absolute extinction (no more than one fish returning over the number of years in a generation) within 100 years is relevant (McClure et al. 2000c). NMFS evaluates the status of the species relative to a standardized criterion of 5% probability of absolute extinction in assessing whether the species has a high likelihood of survival under the proposed action. A 100-year period captures both short- and long-term risk because a population that has a certain probability of extinction within a short time frame, such as 24 years, will have at least that probability of extinction in 100 years. NMFS also reviews a 24-year period for two reasons: 1) because the range of uncertainty around an estimate of the 100-year metric is quite large and 2) because there is potential to further modify the action in the near term through the adaptive management process (if monitoring and evaluation indicate a need for further action to avoid longer-term risks). Absolute extinction is used instead of a quasi-extinction level because of the unambiguous interpretation of this criterion, whereas quasi-extinction levels such as 20, 50, or 100 fish have different meanings for populations of different sizes and capacities in different river systems.

NMFS received many comments on this choice of an acceptable risk level in the July 27 draft. NMFS considers 5% sufficiently conservative, especially when compared to the 10% level used by the International Union for the Conservation of Nature and Natural Resources for its lowest risk category (IUCN 2000). NMFS also received comments on the July 27 draft, suggesting that higher extinction thresholds, ranging from 5 to 350 fish, be applied. NMFS reviewed an analysis of the sensitivity of conclusions to alternative extinction risk thresholds (USFWS 2000a). NMFS knows that risk increases as the threshold is raised, but continues to conclude that absolute extinction is the most biologically meaningful threshold. An extinction threshold of one fish is the only extinction threshold that has the same biological meaning regardless of which index stock or population is addressed.

This extinction criterion is used in preference to the survival threshold in the 1995 FCRPS Biological Opinion. A review by the Independent Scientific Advisory Board (ISAB 1999) considered the survival threshold ". . . insufficiently linked to the ESA considerations of probability of extinction. . . ." This approach was also criticized by a review panel (Barnthouse et al. 1994), which stated that, if the threshold represents a critical level, "it makes little sense to define persistence in terms of the frequency of years in which the populations are below the critical level. Presumably, even one such year is undesirable." If, on the other hand, the threshold represents some less-critical level, the review panel described that level as necessarily arbitrary. The panel also noted difficulties in interpreting the particular thresholds that were eventually used in the 1995 FCRPS Biological Opinion relative to historical performance of those stocks. Botsford (1997) also noted shortcomings of the survival threshold approach.

1.3.1.2.2 Metrics Indicative of Recovery. The recovery metric stated in the 1995 FCRPS Biological Opinion is a relevant measure of the status of the species relative to the recovery component of the jeopardy standard. This recovery metric is defined as the likelihood that the 8-year geometric mean abundance of natural spawners in a population will be equal to or greater than an identified recovery abundance level. Recovery abundance levels have not been finally determined for any of the ESUs; however, the best available estimates of recovery abundance levels for five ESUs and certain component populations or index areas are shown in Table 1.3-1. For the ESUs for which the recovery abundance levels have not been proposed, until recovery levels are determined, NMFS will rely on a combination of the survival criterion and an alternate recovery criterion defined as the level of improvement needed in the productivity of the population to result in a median annual population growth rate (lambda) greater than 1.0 over 48 years. NMFS applies this alternative recovery metric because the recovery abundance level may not yet be specified, but it is certainly higher than the current abundance level. Therefore, at a minimum, a population must be increasing at least slightly to recover.

Ultimately, recovery goals for each ESU will be established using the criteria outlined in the VSP paper (McElhany et al. 2000). Until technical recovery teams formally apply VSP standards to determine recovery goals for all ESUs, NMFS relies on the following:

- Goals established during the quantitative analysis process for the UCR ESUs (Cooney 2000, Ford et al. 1999)

- Abundance goals established in the 1995 recovery plan for the SR spring/summer chinook and fall chinook salmon ESUs

Recovery time periods for each ESU must also be determined by recovery planning. The 1995 FCRPS Biological Opinion evaluated the likelihood of recovery within 48 years. It may be unrealistic to expect populations to return to recovery abundance levels within this time period. Both the 48-year and the 100-year probabilities are reviewed in assessing whether the species has a moderate to high likelihood of recovery under the proposed action.

Table 1.3-1. Interim proposed recovery levels for some Columbia River ESUs.

ESU/Population/Stock	Recovery Abundance Level	Notes
SR spring/summer chinook (at Ice Harbor)	31,440	Source: NMFS (1995c)
SR spring/summer chinook index stocks		
Bear Valley/Elk Creeks	911	Recovery goals for Snake River index stocks defined as 60% of pre-1971 abundance[1] (Source: NMFS 1995c)
Minam River	439	
Imnaha River	802	
Poverty Flats	866	
Johnson Creek	288	
Marsh Creek	426	
Sulphur Creek	283	
SR fall chinook (aggregate pop.)	2,500	Source: NMFS (1995c)
SR sockeye[2]	2,000	Source: NMFS (1995c)
UCR steelhead populations		
Wenatchee River	2,500	Source: draft report on population structure and biological requirements of UCR steelhead and spring chinook salmon (Ford et al. 1999)
Methow River	2,500	
Entiat River	500	
UCR spring chinook populations		
Wenatchee River	3,750	Source: Ford et al. (1999)
Methow River	2,000	
Entiat River	500	

Note: Recovery abundance levels refer to naturally spawning adults.
[1]Pre-1971 abundance for index stocks from ODFW (Tinus 2000).
[2]SR sockeye salmon in Redfish Lake and two other lakes in the Snake River basin.

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2.0 BACKGROUND

2.1 INTRODUCTION

On March 2, 1995, NMFS issued the 1995 FCRPS Biological Opinion. In that opinion, NMFS determined that the operation of the FCRPS, as proposed by BPA, the Corps, and BOR, would jeopardize the continued existence of threatened and endangered SR spring/summer chinook, fall chinook, and sockeye salmon and would adversely modify their critical habitat. The 1995 FCRPS Biological Opinion, therefore, set out an RPA for the operation and configuration of the hydrosystem to satisfy ESA Section 7(a)(2) requirements. The RPA prescribed measures to increase the survival of juvenile and adult salmonids and initiated the development of a long-term system configuration plan. The RPA focused on three strategies:

1. Addressing scientific uncertainties through research and data analysis
2. Requiring immediate survival improvements in the mainstem corridor through increased voluntary spill, a flow augmentation program, transportation improvements, and other measures
3. Committing to a decision on which intensive improvements, if any, would lead to the eventual survival and recovery of all listed salmonids in the Columbia River basin [At that time, only Snake River stocks were listed.]

The 1995 FCRPS Biological Opinion established a process to address the following information needs for the issues:

1. The survival of juvenile salmonids in the migration corridor
2. The effectiveness of juvenile transportation compared with inriver migration
3. The absolute return rates of transported and inriver juvenile migrants under different flow conditions
4. The effectiveness of new technologies such as surface collection
5. The cost, feasibility, and benefits of drawdown and other system alternatives

In the interim, the 1995 FCRPS Biological Opinion called for transporting all juvenile migrants collected and provided optimum inriver conditions for migrants that are not transported. The 1995 FCRPS Biological Opinion established a regional forum of Federal, state, and Tribal fish and wildlife managers to coordinate day-to-day operations during the migration season. The forum is led by the Implementation Team, which oversees the work of subgroups such as the Technical Management Team (see Section 9).

2.2 SUPPLEMENTAL BIOLOGICAL OPINIONS

On May 14, 1998, NMFS issued the 1998 Supplemental FCRPS Biological Opinion. That ESA Section 7 consultation evaluated the effects of the configuration and operations of the FCRPS on newly listed threatened and endangered steelhead in the Upper Columbia River, Snake River, and Lower Columbia River ESUs.

In the 1998 Supplemental FCRPS Biological Opinion, NMFS determined that operating the FCRPS in accordance with the Action Agencies' proposed action, including the measures specified in the RPA of the 1995 FCRPS Biological Opinion (the 1995 RPA), would not jeopardize the continued existence of the newly listed steelhead. The 1998 Supplemental FCRPS Biological Opinion established spring flow objectives at Priest Rapids Dam to protect juvenile fish and expanded the spill program at many mainstem hydro projects, but otherwise left the decision-making process and timing for the long term as in the 1995 FCRPS Biological Opinion.

NMFS issued a second supplemental biological opinion on December 9, 1999.[1] That biological opinion evaluated and documented BOR's planned operation to comply with the 1995 RPA prescription to deliver 427 thousand acre-feet (kaf) of upper Snake River water for flow augmentation and to review the operation of all BOR projects in the Snake River system above Lower Granite Dam. Again, the architecture of the long-term, decision-making process was unchanged from that set out in the 1995 RPA.

NMFS issued a last supplemental biological opinion on February 4, 2000.[2] That opinion considered the effects of FCRPS operations on six species that NMFS listed as threatened or endangered in March 1999. NMFS determined that the 1995 RPA, as modified by the 1998 proposed action and combined with a few additional interim measures, would not jeopardize the continued existence of any of the newly listed species for the rest of the interim period. The decision-making process and timing for the long term, again, remained consistent with the 1995 FCRPS Biological Opinion.

[1] "Biological Opinion—Bureau of Reclamation Operations and Maintenance of its Projects in the Snake River Basin Above Lower Granite Dam: A Supplement to the Biological Opinions Signed on March 2, 1995, and May 14, 1998" (NMFS 1999b).

[2] "Supplemental Biological Opinion—Operation of the Federal Columbia River Power System Including the Juvenile Fish Transportation Program: A Supplement to the Biological Opinions Signed on March 2, 1995, and May 14, 1998, for the Same Projects" (NMFS 2000d).

2.3 DRAFT ENVIRONMENTAL IMPACT STATEMENT

The Corps issued a draft environmental impact statement (EIS) describing alternative configurations and operations of the FCRPS in the lower Snake River for comment during December 1999 (Corps 1999b). The draft EIS was a requirement of the 1995 RPA.

2.4 CURRENT CONSULTATION

After the Corps issued the draft EIS, the Action Agencies reinitiated consultation on the long-term configuration of the hydrosystem by submitting their final biological assessment to NMFS on December 21, 1999.[3] NMFS consulted with the Action Agencies, in coordination with USFWS, and transmitted a draft biological opinion to these agencies on May 17, 2000 (NMFS 2000a). After considering comments from the Action Agencies, as well as other Federal agencies, NMFS issued a revised draft biological opinion, dated July 27, 2000, for review by the state and Tribal comanagers and other interested parties.

2.5 MEETINGS WITH STATE AND TRIBAL REPRESENTATIVES

NMFS held a series of meetings with state and Tribal comanagers that began on February 2, 2000. The Implementation Team and the Columbia Basin Fish and Wildlife Authority (CBFWA) coordinated the meetings, which included affected agencies and Tribes that do not participate in the Regional Forum. NMFS also briefed the Northwest Power Planning Council (NWPPC) and engaged in subsequent discussions with NWPPC members. During those meetings, the comanagers and others commented on the technical elements of the proposed action and potential RPA measures.

NMFS invited consultation with the 13 Sovereign Tribes of the Columbia River basin in a letter from B. Brown. The letter, dated January 26, 2000, was faxed and mailed to each Tribal chairman. Copies were also transmitted to the Columbia River Inter-Tribal Fish Commission (CRITFC), the Upper Columbia United Tribes (UCUT), CBFWA, and NWPPC. NMFS invited each Tribe to participate in the ESA Section 7 consultation with the Action Agencies to develop the 2000 FCRPS Biological Opinion. The letter recognized that Tribal rights and Tribal trust resources could be affected by NMFS' findings and recommendations and actively solicited Tribal expertise in developing analyses of effects, biological requirements, and mitigation strategies for listed salmon and steelhead. NMFS also offered to meet individually with the Tribes on a government-to-government basis. In response to this invitation, NMFS met with the Burns Paiute, Coeur d'Alene, Colville Confederated, Kalispel, Kootenai, Confederated Salish & Kootenai, Nez Perce, Shoshone-Bannock, Shoshone-Pauite, Spokane, and Umatilla Tribes and the Yakama Nation and with representatives of UCUT and CRITFC. Dates and locations of staff- and executive-level meetings are shown in Table 2.5-1.

[3] "Multi-Species Biological Assessment of the Federal Columbia River Power System" (BPA et al. 1999)

Table 2.5-1. Consultation and conferencing with Columbia Basin Tribes on development of Draft 2000 FCRPS Biological Opinion and Basinwide Recovery Strategy.

Location	Executive-Level	Staff-Level
Washington, D.C.	1/24 and 25/2000	–
Helena, Montana	--	2/25/2000
Spokane, Washington	3/8 and 3/24/2000	2/9 and 3/16/2000
Orofino, Idaho	--	3/10/2000
Lewiston, Idaho	3/14/2000	--
Olympia, Washington	3/29/2000	--
Portland, Oregon	4/3/2000	1/13, 3/29, 4/7, 4/14, 4/17, and 6/7, 2000

NMFS met with the Tribes in a series of technical-level planning and policy-level Tribal council meetings during the comment period for the draft biological opinion issued on July 27, 2000. The purpose of the planning meetings was to identify issues that the respective Tribal governments (or their representatives) would want to discuss at subsequent policy-level meetings. The dates and locations of these meetings, and the Tribes involved, are shown in Table 2.5-2.

The Tribes asked the Federal agencies to designate a lead agency for historic preservation and to explain how cultural resource issues would be addressed. In response, the Federal Caucus discussed designating a lead agency to manage cultural resources related to Basinwide Recovery Strategy actions. The consensus was that Basinwide Recovery Strategy implementation would trigger individual agency responses to the National Historic Preservation Act (NHPA), at which point a lead agency (or agencies) would assume coordination responsibility. The Federal Caucus agreed, therefore, that a regional, multiagency, Tribal, state, and local forum should be formed to keep track of overall implementation. Beginning in late summer 2000, Federal Caucus representatives conveyed these findings to the Tribes and received comments and suggestions. The Federal Caucus will continue to consult and coordinate with the Tribes and plans to integrate a forum on historic preservation and cultural resources into the restoration programs.

Table 2.5-2. Technical and policy level meetings with the Columbia Basin Tribes on Draft 2000 FCRPS Biological Opinion and Basinwide Recovery Strategy issued on July 27, 2000.

Tribe(s)	Location	Date
Technical-Planning Meetings		
Burns Paiute, Shoshone-Paiute, and Shoshone-Bannock	Boise, Idaho	9/20/2000
Colville	Nespelem, Washington	8/22-23/2000
Coeur d'Alene and Kootenai[1]	Spokane, Washington	9/22/2000
Nez Perce[2]	–	–
Spokane	Spokane, Washington	8/15/2000
Warm Springs	Warm Springs Reservation	9/18/2000
Umatilla[2]	–	–
Yakama	Yakama Reservation	10/3/2000
Policy-Level Council Meetings		
Burns Paiute, Shoshone-Paiute, and Shoshone-Bannock	Ft. Hall Reservation	10/24/2000
Colville	Spokane, Washington	9/27/00
Coeur d'Alene and Kootenai (policy+technical)[1]	Plummer, Idaho	11/8/2000
Nez Perce[2]	–	–
Spokane	Wellpinit, Washington	9/25/2000
Warm Springs[3]	–	–
Umatilla[2]	–	–
Yakama	Yakama Reservation	10/17/2000

[1] The Kalispel and Confederated Salish and Kootenai Tribes were invited to this meeting but did not participate.
[2] The Nez Perce and Umatilla Tribes have indicated that they wish to defer technical planning and/or policy-level meetings until they have completed their reviews of the draft biological opinion and Basinwide Recovery Strategy and have submitted comments. They also have indicated that policy-level meetings would be more appropriate after NMFS has had an opportunity to review the Tribal comments. NMFS, by letter, stated that it understood the Tribal position and was prepared to meet at some future date. No date has been established.
[3] The Warm Springs Tribal staff has indicated a desire to host a policy-level consultation meeting in the future. As of this writing, no date has been established.

2.6 FEDERAL REVIEW TEAMS FOR THIS CONSULTATION

2.6.1 The Biological Effects Team

The Biological Effects Team was charged with estimating the effects of current operations and potential future configurations and operations on the survival of listed juvenile outmigrants. NMFS used this information to analyze the listed species' biological requirements in the action area (Section 6.1.1), as well as at the species level (Section 6.1.2). The team included Federal biologists and engineers representing NMFS, the Corps, and BPA. NMFS Hydro Program staff then completed the biological effects analysis.

For juvenile fish using the mainstem Columbia and Snake rivers as a migration corridor, simulation modeling is the primary method used to evaluate the effects of the proposed action on the action area biological requirements. The Biological Effects Team agreed to use NMFS' simulated passage (SIMPAS) model to evaluate the biological benefits of juvenile salmonid passage measures. SIMPAS is a fish passage accounting model that apportions the run to various passage routes (i.e., turbines, fish bypass system, sluiceway/surface bypass, spillway, and/or fish transportation) based on empirical data and input assumptions for fish passage parameters.

The Biological Effects Team reviewed and analyzed the fish passage assumptions NMFS used in earlier fish passage modeling exercises, those developed in the Plan for Analyzing and Testing Hypotheses (PATH) process, and the most recent empirical data to determine the fish passage parameters for input into the SIMPAS model. The team also used the latest compilation of fish passage information from the four white papers the Northwest Fisheries Science Center (NWFSC) recently prepared on 1) "Passage of Juvenile and Adult Salmonids Past Columbia and Snake River Dams," 2) "Predation on Salmonids Relative to the Federal Columbia River Power System," 3) "Salmonid Travel Time and Survival Related to Flow in the Columbia River Basin," and 4) "Summary of Research Related to Transportation of Juvenile Anadromous Salmonids Around Snake and Columbia River Dams" (NMFS 2000e,f,h,i).

The Biological Effects Team reviewed spill and fish guidance efficiency, spill/gas caps, turbine, spillway, sluiceway, and bypass system survival, and diel passage patterns. Those parameters were quantified for each FCRPS dam and for both spring and fall chinook salmon (considered indicator species for the spring and summer passage seasons, respectively).

As a result of the collaborative analytical effort, on March 20, 2000, the team prepared and sent out a review draft report to the 13 Tribes and other regional fisheries comanagers. The draft documented preliminary results of SIMPAS model runs incorporating current passage conditions (and alternative proposed future actions under consideration in the 2000 ESA Section 7 consultation process).

2.6.2 Hydroregulation (Modeling) Team

The Hydroregulation Modeling Team was formed by the Federal agencies during the ESA Section 7 consultation process and charged with conducting hydroregulation modeling studies to simulate alternative river operations and the costs of such operations for the Columbia River hydrosystem. The team included Federal system analysts, engineers, and biologists representing NMFS, the Corps, BPA, BOR, and USFWS. BPA assessed the effects and estimated costs of alternative future water management actions for both NMFS and USFWS biological opinion operations by using its HYDSIM hydroregulation model and a series of power market pricing and marketing models. The HYDSIM model simulates flow/reservoir management and fish spill operations on a monthly basis at FCRPS and other Columbia Basin projects to meet an array of purposes, including flood control, anadromous and resident fish protection, projected energy loads, Columbia Basin Treaty obligations, and other project-specific, nonpower requirements. Model outputs include mean monthly discharge at various project locations, including those for which NMFS has set flow objectives (Priest Rapids, McNary, Bonneville, and Lower Granite dams), as well as end-of-month reservoir elevations for the major storage projects.

More than 30 system hydroregulation studies of various operational alternatives were conducted and reviewed by the Hydroregulation Modeling Team. The Section 7 consultation team selected a final modeling scenario to analyze both the NMFS and USFWS biological opinions, including a base case study. The base case model study placed priority on meeting the reservoir operating provisions specified in NMFS' 1995 and 1998 Supplemental FCRPS Biological Opinions and the USFWS' 1995 Biological Opinion on Kootenai River sturgeon. Subsequent modeling scenarios evaluated the effects of including the VARQ modified flood control curves, deeper reservoir drafts at selected FCRPS projects, and increasing the discharge from Mica and/or Revelstoke projects during the summer. The final hydroregulation study evaluated near-term implementation of the RPA, including deeper drafts at certain FCRPS storage projects, VARQ flood control operation, biological opinion spill levels, and fall spawning flows below Bonneville Dam.

HYDSIM model output consisted of a monthly flow detail and a summary of the effect of project operations by enumerating the frequency with which the NMFS flow objectives are met on a monthly and seasonal basis at Lower Granite, Priest Rapids, McNary, and Bonneville dams. The effect of flow operations on the frequency with which storage reservoirs would achieve upper (flood control) rule curve elevation on April 10 and refill by June 30 was also summarized. See Section 9.7.1.3 for a detailed summary of hydroregulation modeling results.

2.6.3 Performance Standards Team

The Performance Standards Team was another team formed by the Federal agencies during the Section 7 consultation process. The team was composed of members from NMFS, USFWS, BPA, the Corps, and BOR. It was charged with developing a set of performance measures and associated goals or standards that NMFS and the region could use to judge the success of the salmon recovery effort. The team began meeting in January 2000. Its work culminated in a draft report entitled, "Development of Provisional Performance Measures and Standards for Federal Hydrosystem Impacts in the Columbia River Basin," which was released to regional fishery agencies and Tribes for review on March 24, 2000. In its paper, the team developed a process for formulating performance measures in the context of three major objectives:

1. It proposed a procedure for placing hydrosystem-related performance measures and standards in the context of performance measures and standards for other, nonhydrosystem actions affecting various life-history stages.
2. It developed a suite of provisional performance measures and standards applicable to hydrosystem-related actions, including performance measures for FCRPS hydrosystem activities and for natural survival.
3. It developed a blueprint for revising the hydrosystem-related performance measures and standards in the context of mitigation measures using nonhydrosystem actions, i.e., as part of a comprehensive recovery planning effort addressing habitat, harvest, hatcheries, and hydropower.

After the report was released, NMFS built on the efforts of the team in developing and selecting population-level measures of salmon survival and recovery for each species and hydrosystem performance measures, presented in Section 1.3.1.1.

2.6.4 Water Quality Team

The Federal agencies formed the Water Quality Team during the ESA Section 7 consultation process. The team consisted of members from NMFS, USFWS, BPA, the Corps, BOR, and the U.S. Environmental Protection Agency (EPA). It was charged with development of a water quality plan for the mainstem Columbia and Snake rivers. The team also began meeting in January 2000. Its efforts culminated in a paper entitled, "Development of a Water Quality Plan for the Columbia River Mainstem: A Federal Agency Proposal." It is included in this biological opinion as Appendix B.

The water quality plan includes basinwide goals for total dissolved gas (TDG) and water temperature in the Columbia River basin. In its paper, the team outlined how a water quality plan could be developed and implemented in the basin. The team developed a water quality planning process for deciding on both structural and operational water quality measures. The strategy of the water quality plan is to identify ongoing activities and planned-for improvements in fish survival that also serve to improve water quality by reducing TDG and water temperature. The team addressed long-term structural, operational, and procedural measures for water quality improvements, as well as details concerning the process for developing a water quality plan (Appendix B).

2.7 RELATED REGIONAL FORUMS

NMFS developed its biological opinion on the effects of FCRPS operations in coordination with other ongoing Federal and regional processes. The process is described in the following sections.

2.7.1 Federal Caucus/Basinwide Recovery Strategy

The Federal Caucus includes NMFS, the Corps, BOR, BPA, EPA, the Bureau of Indian Affairs (BIA), the Bureau of Land Management (BLM), USFWS, and the U.S. Forest Service (USFS). The primary role of the Federal Caucus has been to develop a comprehensive multispecies conceptual recovery plan that describes a range of potential Federal activities that could meet ESA obligations and rebuild Columbia basin stocks (Basinwide Recovery Strategy). Non-Federal (Tribal, state, local, and private) activities are also considered in the Basinwide Recovery Strategy to the extent that they can contribute to the recovery of ESA-listed species in the Columbia River basin. Recovery options are considered and analyzed across actions affecting each life stage of ESA-listed fish: habitat, hatcheries, harvest, and the hydropower system. These options are broadly described for the purpose of engaging a regional discussion.

After the draft Basinwide Recovery Strategy was released, the Federal Caucus engaged in government-to-government consultations with 13 Native American Tribes in the Columbia River basin. In addition, more than 9,000 Pacific Northwest citizens testified in 15 public hearings. The Federal Caucus also received more than 60,000 written comments. On the basis of the feedback, the Federal Caucus is attempting to balance and respect multiple competing interests, including the needs of anadromous and resident aquatic species, Tribal trust and treaty obligations, international commitments, and the economic and cultural concerns of all citizens in the region.

The Basinwide Recovery Strategy attempts to balance these issues by recommending new, intensive measures basinwide and across the salmon and steelhead life cycle. It builds on existing measures for better balance and bolsters non-Federal decisions and actions with Federal support and funding. It recognizes the need to consider the broader cultural concerns of threatened and endangered species recovery. It links discrete actions across the ecosystem and the life stages of salmon and steelhead to connect biology and ecology basinwide. These actions will also benefit resident fish and other aquatic species.

The Basinwide Recovery Strategy serves four major purposes. First, it provides an overall, conceptual recovery strategy encompassing threatened and endangered aquatic species affected by the FCRPS. Second, it establishes a context for the new biological opinions on the operation and configuration of Federal dams issued by NMFS and USFWS. It shows how the actions called for in the hydrosystem fit with other related recovery initiatives or ongoing policies in the Columbia River basin. Third, the draft Basinwide Recovery Strategy provides a tool for engaging and informing the general public about the issues affecting salmon and steelhead, resident fish, and other aquatic species, and the policy choices under consideration in the effort to recover them. Fifteen public hearings and seven scientific workshops were conducted after the draft was released, representing an unprecedented opportunity for the public to participate in the formation of natural resource management policies. Fourth, as a product of the Federal Caucus, the Basinwide Recovery Strategy served as an organizing tool for the Federal agencies involved to align their programs and activities to ensure maximum coordination and policy uniformity from the Federal perspective. The Basinwide Recovery Strategy is not a decision document. Its content is neither regulatory nor binding in nature. Rather, it presents a set of strategies, goals, and overall direction toward which the agencies in the Federal Caucus will commit to move their programs and policies.

In making decisions to correct the decline of anadromous fish and steelhead, as well as other listed fish and wildlife resources, the Federal Caucus will comply fully with all applicable Federal laws and executive orders. These include, but are not limited to, NEPA, ESA, CWA, and NHPA, as well as trust responsibilities applicable to the unique and longstanding relationship between the U.S. government and the region's federally recognized Indian Tribes.

2.7.2 Plan for Analyzing and Testing Hypotheses

PATH is a structured program of formulating and testing hypotheses involving the fundamental biological issues surrounding recovery of ESA-listed salmon and steelhead in the Columbia River basin. The PATH decision analysis focused on alternative hydrosystem actions that could be used to prevent the extinction of and aid in the recovery of SR spring/summer and fall chinook salmon. The work of the PATH group underlies the life cycle analyses used in this biological opinion for those ESUs.

2.7.3 Cumulative Risk Initiative

The CRI is a network of NMFS scientists working to synthesize information and provide clear, consistent, and scientifically rigorous decision support for salmonid conservation. The CRI process of the NMFS NWFSC has used matrix modeling of salmonid population dynamics to evaluate extinction risks and the sensitivity of population growth for each ESU to changes in survival in specific life-history stages as a result of management actions. In this biological opinion, the analysis was used to determine potential combinations of basinwide strategies to achieve the biological objectives related to recovery of ESA-listed species.

To involve, obtain input from, and inform both the technical scientific community and the community of policymakers, NWFSC established a series of workshops. The audience alternated between highly technical experts in specialized areas and a mix of policy and technical participants. Table 2.7-1 outlines the workshop schedule.

Table 2.7-1. CRI workshop schedule.

Date	Purpose	Level
Jul. 22-23, 1999	Technical introduction to CRI analytical approach	Technical
Aug. 31, 1999	Putting Basinwide Recovery Strategy together	Technical and policy
Sept. 29-30, 1999	Assessing productivity of habitats with respect to salmon populations	Technical
Oct. 27, 1999	Data-poor, rapid analysis assessments for other ESUs in Columbia River system	Technical and policy
Dec. 7-8, 1999	Spatial analyses	Technical
Mar. 29, 2000	Cosponsored by American Rivers	Technical and policy
Sept. 19, 2000	Recovery planning: CRI risk calculations and assessing habitat options	Technical

2.7.4 NMFS White Papers

In October 1999, NMFS synthesized existing information on salmonid passage through the FCRPS in four white papers that discussed dam passage, transportation, flow/survival relationships, and predation, respectively. The papers also characterized uncertainties associated with existing data and raised in recent analyses by regional forums. The papers were released for regional review and comment.

After the regional review, the white papers were modified to reflect comments and information from numerous reviewers and resource agencies. Contributors include the Oregon Department of Fish and Wildlife (ODFW), USFWS, Idaho Department of Fish and Game, Columbia Basin Fish and Wildlife Authority, Washington Department of Fish and Wildlife (WDFW), CRITFC, U.S. Geological Survey (USGS), Fish Passage Center, Idaho Water Users Association, Inc. (IWUA), and IDACORP, Inc. The four modified papers are now available on the NWFSC home page (web site: www.nwfsc.noaa.gov/pubs/nwfscpubs.html).

2.7.5 Quantitative Analysis

NMFS, in cooperation with other parties, is developing the quantitative analysis report (QAR) for the listed species that may be affected by the non-Federal, mid-Columbia projects (i.e., those operated by the public utility districts (PUDs) of Douglas, Chelan, and Grant counties. The QAR is a quantitative assessment of the biological requirements and likelihood of survival and recovery for endangered UCR spring chinook salmon and endangered UCR steelhead. As with PATH, much of the work of the QAR group underlies the life cycle analyses in this biological opinion for those ESUs.

2.7.6 Northwest Power Planning Council's Multispecies Framework Project/Ecosystem Diagnosis and Treatment Analysis

NWPPC's Multi-Species Framework Project is developing visions, strategies, and alternatives for recovering fish and wildlife resources in the Columbia River basin and analyzing the biological and social/human effects of alternatives. The Hydro Work Group of the Federal Caucus and the Framework Project staff jointly evaluated alternative measures for system configuration and operations and agreed to the specifications of those measures in seven Framework Project alternatives and three Federal scenarios. The joint group also coordinated the analysis of hydrosystem operations, the biological studies and evaluations, and other Federal and Framework Project tasks related to the hydrosystem.

The Framework Project will characterize a set of alternative futures for the Columbia River basin that focus on a long-term vision for the region. The Framework Project uses an analytical technique called ecosystem diagnosis and treatment (EDT) to compare the ecological effects of various alternatives and describe their economic, social, and cultural impacts. The analysis focuses on long-term conditions and emphasizes habitat actions.

3.0 PROPOSED ACTION

3.1 OPERATION AND CONFIGURATION OF FCRPS AND BOR PROJECTS

The Action Agencies have proposed, as described in their biological assessment (BPA et al. 1999), to continue current FCRPS operations that implement the 1995 RPA as supplemented, while developing measurable performance standards to guide future system improvements.

The FCRPS operates to serve an array of individual project and system purposes. Individual project purposes vary widely and may include power generation, flood control, irrigation, recreation, fish and wildlife, and other purposes defined by congressional authorizations. Systemwide purposes focus on supplying electrical energy to meet existing and projected loads, flood control, and more recently, salmon recovery.

In addition to the BOR projects in the FCRPS (e.g., certain facilities and operations at the Grand Coulee Project and Hungry Horse Dam and reservoir), the Action Agencies propose to continue current operations of the BOR's other projects, as described in the biological assessment.

Elements of the proposed action designed to enhance salmon survival are described below.

3.2 OBJECTIVES FOR SALMON AND STEELHEAD

The Action Agencies recommend that mainstem flow operations be based on the 1995 RPA as supplemented by the 1998 FCRPS Biological Opinion. For SR salmon and steelhead, the seasonal average flow objectives would range from 85 to 100 thousand cubic feet per second (kcfs) during spring (April 3 to June 20) and 50 to 55 kcfs during summer (June 21 to August 31) at Lower Granite Dam. Flow objectives in the lower Columbia River, as measured at McNary Dam, would range from 220 to 260 kcfs during spring (April 20 to June 30) and 200 kcfs during summer (July 1 to August 31). The flow objectives in any given year would be determined using a sliding scale based on forecasted runoff, as specified in the 1995 RPA. To benefit UCR steelhead, in the mid-Columbia reach the 1998 Supplemental FCRPS Biological Opinion set a further spring flow objective of 135 kcfs (April 10 to June 30) at Priest Rapids Dam.

System operators will continue to confer with NMFS and the regional fisheries comanagers to determine how to best manage in-season conditions relative to the seasonal average flow objectives. Flow management would continue to emphasize refill of headwater storage projects by June 30 in the Snake River basin and by the end of the July 4 weekend in the Columbia River basin each year (or as soon as possible after July 4 at Libby), although that priority would remain subject to in-season considerations. Reservoir drafts would be limited to 80 feet at Dworshak (elevation 1,520 feet), 10 feet at Grand Coulee (elevation 1,280 feet), 20 feet at Hungry Horse (elevation 3,540 feet) and 20 feet at Libby (elevation 2,439 feet).

For fall chinook and chum salmon spawning below Bonneville Dam, the FCRPS would be operated to use storage to augment natural flows, in an attempt to provide a flow level of 125 kcfs during early November through early April while maintaining the 1995 RPA requirement for storage projects to be at their upper (flood control) rule curve elevation on April 10 of each year. The Action Agencies recognize that in some years it may be impossible to meet both these flows and the reservoir levels in the spring, in which case priority will be on refill. As natural conditions permit, a conservative stepwise approach would allow higher flows during late fall and early winter (i.e., providing additional spawning habitat in the Ives Island area). If in-season data on reservoir operations indicate that the 1995 RPA, the 1998 Supplemental FCRPS Biological Opinion, and Vernita Bar flow requirements cannot be met by providing chum flows, the Action Agencies will confer with NMFS to modify operations.

3.2.1 Water Quality

The Action Agencies propose to continue to operate the FCRPS to reduce water temperatures during periods of juvenile and adult fish migration and to reduce the harmful effects of elevated levels of spill-generated TDG on anadromous and resident fish. Based on recommendations of the Regional Forum's Technical Management Team, flows would be released from Dworshak Dam to help reduce water temperatures in the lower Snake River for migrating fall chinook salmon and steelhead. Gas concentrations would be controlled by limiting the amount of involuntary spill at all dams, installing gas-abatement structures that reduce the generation of TDG, and taking other operational and power-marketing actions. In years of high runoff, inflows to FCRPS projects can result in forced spill or TDG levels exceeding 120%. In addition, voluntary spill to improve fish passage will be managed to 115% or 120% TDG, or as approved through variances to the 110% gas standard.

3.2.2 Specific Project Operations

3.2.2.1 Libby

Libby Reservoir would be maintained throughout fall and winter to achieve a 75% chance of reaching flood control elevation on April 10. From late spring through July, the Action Agencies would release water to achieve the goals set for white sturgeon in the Kootenai River. If the elevation of Lake Koocanusa is above 2,439 feet at the conclusion of the sturgeon operations, the Action Agencies would use water above elevation 2,439 feet to provide flows to meet salmon objectives within the turbine capacity of Libby Dam. Efforts would be made to minimize the effect of a second peak flow fluctuation below Libby until August 31 for the benefit of resident fish species. The Action Agencies would consider the Technical Management Team's recommendations for Libby operations, along with others (including the NWPPC's) in making final operating decisions.

3.2.2.2 Hungry Horse

Hungry Horse Dam would be operated during the fall and winter months to achieve a 75% chance of refill to its April 10 upper rule curve. Hungry Horse Dam would also operate to meet a year-round minimum instantaneous streamflow of 3,500 cubic feet per second (cfs) in the Flathead River near Columbia Falls to protect instream habitat for native resident fish populations, including ESA-listed bull trout. Using water supply forecasts, the Action Agencies would operate the project to refill no later than the end of the July 4 weekend. The Action Agencies would draft the project to 3,540 feet to assist in meeting the summer anadromous fish flow objective at McNary Dam, as coordinated through the Technical Management Team. Because a selective-withdrawal, water-temperature-control structure has been installed at Hungry Horse, the Action Agencies would plan water releases to try to meet state-recommended water temperature guidelines during the period June through October.

3.2.2.3 Grand Coulee

Grand Coulee Dam would be operated according to the 1995 RPA and the 1998 FCRPS Supplemental Biological Opinion. The Action Agencies would operate the project during January through April 10 to ensure an 85% confidence of refill to flood control elevation. BOR would limit winter drafts to elevation 1,265 feet, 1,260 feet, 1,250 feet, and 1,240 feet at the end of December, January, February, and March, respectively (except when deeper drafts would be needed for flood control or power emergencies). Beginning in April, Grand Coulee would be operated to refill to full pool (elevation 1,290 feet) by the end of the July 4 weekend. From April 10 through August 31 of each year, releases would be made to augment flows for anadromous fish, as coordinated by the Technical Management Team. The reservoir would be drafted as low as 1,280 feet elevation by August 31 during average and above-average water conditions. After Labor Day weekend, the Action Agencies would try to refill Lake Roosevelt by the end of September to elevation 1,283 feet or higher for kokanee spawning needs. Water would also be released from Grand Coulee to meet an average daily minimum flow requirement of approximately 30 kcfs or higher as needed to meet minimum flows at Priest Rapids Dam. The Priest Rapids minimum flow is the higher of 36 kcfs or the Vernita Bar flow requirement during the December-through-May period. The Action Agencies would continue to coordinate with regional interests to develop operations that minimize the potential stranding of post-emergent fall chinook in the Hanford Reach.

3.2.2.4 Albeni Falls

The typical maximum reservoir operating range for this project, which controls water surface elevations in an upstream natural lake, is from elevation 2,051 to 2,062.5 feet. The reservoir would be drawn down beginning on Labor Day for power generation and flood control purposes and would typically achieve its lowest elevation between November 15 and 20 of each year. Variations in lake level after November 20 would be controlled to within 1 foot to protect established kokanee spawning areas. Experimental operations have occurred for the last several winters to examine the relationship between winter lake levels and kokanee spawning. During winter 2000, a lake elevation of 2,053 feet was monitored to evaluate potential effects on resident species and lake productivity. Before this experimental operation, Albeni Falls was drafted farther, to elevation 2,051 feet, during winter operations. Under the Action Agencies' current activities, operations during January through March 31 would allow for some fluctuation in reservoir elevations for power production and flood control, but the elevation could not drop below the last minimum water level established in December. From April through June, the reservoir would refill. During the summer months, the fluctuations would be maintained within a 0.5-foot limit (i.e., between 2,062- and 2,062.5-foot elevation).

3.2.2.5 Dworshak

Dworshak Dam would continue to be used to augment flows in the Snake River for the intended benefit of juvenile and adult summer-migrating salmon and steelhead from April through August. Dworshak would be full by June 30 and would draft to its August 31 draft limit of elevation 1,520 feet (80 feet from full pool) to provide water to meet anadromous fish flow objectives. The project would be operated to release a minimum of 1,300 cfs between September and April to enhance the probability of refill to the flood control rule curve elevation by the beginning of April. Because Dworshak Dam has a temperature control outlet facility and a multilevel outlet, cool water would typically be released during July or August to reduce water temperatures in the lower Snake River.

3.2.2.6 BOR's Snake River Projects

In the July 27, 2000, Draft FCRPS Biological Opinion, the proposed action included the continued operation and maintenance of BOR's 11 projects in the Snake River basin (Table 3.2-1). The Department of Justice, BOR, and NMFS have been engaged in negotiations with the state of Idaho and Idaho water interests to settle Federal and Tribal water claims in the Snake River basin as part of the general adjudication of water rights taking place in Idaho District 1 Court. Termed the Snake River Basin Adjudication, this process will define the water rights under Idaho law of all parties having interests in Snake River basin water within Idaho's boundaries. To date, agreement has not been reached. Since discussions are continuing, BOR has indicated that the proposed action for its 11 irrigation projects in the Snake River basin may be different from those measures set forth in its December 21, 1999, biological assessment. Accordingly, BOR has asked to extend the consultation on these 11 projects pending a revised proposed action and analysis of effects. Because all BOR projects upstream of Hells Canyon Dam, including those in Oregon, have similar and additive effects on listed fish, NMFS and BOR agree that it would be best to consult on these projects simultaneously. Therefore, at BOR's request, NMFS has agreed to extend the current consultation with regard to BOR's projects in the Snake River basin and to exclude those projects from this biological opinion. BOR anticipates providing the necessary additional information, and NMFS anticipates issuing a supplemental biological opinion on those projects before water must be delivered from the projects for irrigation use in the 2001 growing season.

Table 3.2-1. BOR projects in Snake River basin.

Project	Location	Subbasin or Stream
Minidoka	Southern Idaho and western Wyoming from Twin Falls Idaho to Jackson Lake, Wyoming	Snake River
Palisades	Eastern Idaho, on Wyoming border	Snake River
Michaud Flats	Southern Idaho, near Pocatello	Snake River
Little Wood River	South-central Idaho, north of Twin Falls	Little Wood River
Boise	Southwest Idaho, near Boise	Boise and Payette rivers
Mann Creek	Southwest Idaho, northwest of Boise	Weiser River
Owyhee	Eastern Oregon and southwest Idaho, near Ontario Oregon	Owyhee and Snake rivers
Vale	Eastern Oregon, west of Ontario	Malheur River
Burnt River	Eastern Oregon, south of Baker City	Burnt River
Baker	Eastern Oregon, near Baker City	Powder River
Lewiston Orchards	West-central Idaho, near Lewiston	Clearwater River

3.2.2.7 Columbia River Treaty and Non-Treaty Storage

To improve the likelihood of achieving salmon flow objectives in the mainstem Columbia River, the Corps and BPA propose to continue to negotiate mutually beneficial agreements with BC Hydro annually for use of their Columbia River Treaty storage and non-Treaty storage in Canada. Under Treaty operations, these actions include 1 million acre-feet of storage for salmon flow augmentation in the Columbia River, stored above the Detailed Operating Plan Treaty Storage Regulation levels from January to April 15 and then released from May through July, and storage exchanges between Libby and Canadian reservoirs, which would reduce potential adverse effects of salmon flow augmentation drafts on recreation, resident fish, and power in the U.S. and Canada. Under the Non-Treaty Storage Agreement, both BPA and BC Hydro store water in Mica Reservoir during May and June for release in July and August. BPA releases all its May/June stored water during July and August for salmon flows, whereas Canada releases half of its May/June stored water during July and August and the other half at its discretion.

3.2.3 Spill for Fish Passage

Spill is an action to reduce turbine-related mortality of juvenile salmon and steelhead at lower Snake and Columbia River hydroelectric projects. Spill will be at the levels recommended in the 1998 Supplemental FCRPS Biological Opinion, assuming that waivers are obtained from the states of Oregon and Washington to exceed their 110% TDG state water quality standards. The Action Agencies would continue to provide spill for fish passage, but not to exceed TDG levels allowed under the standard or any modifications to it.

3.2.4 Juvenile Fish Transportation

Juvenile salmonids would be collected at several dams on the lower Snake and Columbia rivers and transported downstream by truck or barge to release points below Bonneville Dam in an effort to improve survival over that experienced by inriver migrants. The Action Agencies would continue to provide spill levels that spread the risk between transported and inriver migrants. Spring migrants would not be transported from McNary Dam. Generally, summer juvenile migrants (those collected after the June 20 planning date) would be transported from all four transport facilities. Spill would be limited during that period so that more of the run would approach the powerhouse and be diverted by screens into collection facilities. Once collected, nearly all would be transported by barge or truck to below Bonneville Dam and released.

3.2.5 Minimum Operating Pool (MOP)

Some mainstem run-of-river FCRPS reservoirs on the lower Snake River and John Day Reservoir on the Columbia River would be lowered during the spring and summer migration periods to increase water velocity (intended to increase the migration rate and survival of salmonid smolts). Three of the lower Snake River facilities (Little Goose, Lower Monumental, and Ice Harbor dams) would be operated within 1 foot of the MOP from April 3 until adult fall chinook begin to enter the Snake River, as recommended by the Technical Management Team. Lower Granite Dam would be operated within 1 foot of the MOP from April 3 through November 15 of each year. After November 15, all four reservoirs would be operated within their normal 5-foot operating ranges. McNary, The Dalles, and Bonneville reservoirs would be operated within their normal ranges. From April 20 to September 30 each year, John Day Reservoir would be operated within a 1.5-foot range above elevation 262.5 feet, as long as irrigation withdrawal remained unaffected and additional space was not needed for flood control. The pool elevation would be raised if irrigation pumping problems occurred.[1] During the fall and winter months, all four lower Columbia River projects would be operated within their normal operating range, with the exception of temporary flood control storage at John Day, if needed.

3.2.6 Peak Turbine Efficiency Operation

Under the current action, the Action Agencies would operate turbines at the eight FCRPS mainstem Snake and Columbia River projects at a high efficiency (within 1% of peak operating efficiency) to reduce the mortality of fish passing through turbines. Operations outside this range would be limited and most likely implemented at the recommendation of the Technical Management Team to abate supersaturated levels of TDG. Specifics of turbine operations that would achieve 1% efficiency are contained in the Corps' annual Fish Passage Plan.

[1]It has been determined that John Day Reservoir cannot be operated at its MOP elevation of 257 feet during the juvenile fish migration season, because of adverse effects on irrigation pumping.

3.2.7 Fish Passage Facilities

3.2.7.1 Juvenile Fish Bypass

Juvenile fish bypass would be provided at Corps mainstem hydroelectric projects by a variety of methods, including screened turbine intakes with bypass/collection facilities at Lower Granite, Little Goose, Ice Harbor, Lower Monumental, McNary, John Day, and Bonneville dams; ice and trash sluiceway passage at The Dalles Dam; and/or spill for fish passage. Surface bypass technology is under evaluation at Lower Granite, Bonneville, and John Day dams. Juvenile fish bypass facilities would be operated continuously during the fish passage period from April through November. All juvenile fish bypass systems would be operated and maintained based on criteria in the Corps' Fish Passage Plan. The plan would be reviewed and updated annually after coordination with the regional fisheries agencies and Indian Tribes and in coordination with NMFS. In-season changes to operating criteria and maintenance schedules may be recommended by the Technical Management Team.

3.2.7.2 Adult Fish Passage

All the mainstem FCRPS hydroelectric dams in the Columbia/Snake migration corridor have fish ladders and associated auxiliary water supply and powerhouse collection facilities. The adult fish passage period would be March through November at Bonneville, The Dalles, and John Day dams and March through December at McNary and the four lower Snake River projects. Criteria for the operation and maintenance of adult passage facilities would be also contained in the Corps' Fish Passage Plan. Adult salmonids (and other species) would be counted at each mainstem dam, with the schedule varying according to location and time of year.

3.2.8 Other Activities

A number of research studies covering various aspects of juvenile and adult fish passage would be implemented annually based on provisions in NMFS' biological opinions and through coordination with regional work groups. These studies would be intended to provide information related to key passage uncertainties, for improving operational criteria, modifying or improving existing fish passage facilities, and constructing new passage facilities.

Special operations will be necessary for several research studies developed in response to the actions identified in the NMFS biological opinion. Their successful implementation will depend on special project operations. Research-related project operations would be developed with NMFS, coordinated with the regional forums, and identified in the Fish Passage Plan.

3.2.9 Predator Control Program

The Northern Pikeminnow Management Program, designed to substantially reduce predation losses of juvenile outmigrants, would continue. The program includes harvest technology research, prey protection measures, basic biological research, and a bounty- or sport-reward fishery to encourage the public to harvest northern pikeminnows. Caspian terns have also been identified as a major predator on juvenile salmonids, particularly in the Columbia River estuary near Rice Island. The Action Agencies would continue to conduct studies to determine the significance of predation by fishes and birds throughout the FCRPS and to identify measures to reduce juvenile salmonid losses to these predators. The measures may include expanding activities that are already under way (e.g., avian lines, water cannons), as well as initiating new measures.

3.2.10 Adaptive Management Framework Through Adoption of Performance Measures

The Action Agencies' biological assessment focuses on establishing a course of action for the FCRPS that avoids jeopardy and facilitates the future recovery of listed stocks. Avoidance of jeopardy and facilitation of recovery necessarily requires that the Action Agencies consider actions and improvements in the hydrosystem in connection with actions and improvements expected for habitat, harvest, and hatcheries. Specific actions identified above would provide the base for future operations and actions in the hydrosystem, subject to adjustment over time. The biological assessment also outlines a proposed "Construct for Achieving Survival Improvements" that would establish measurable biological performance standards for the hydrosystem, prioritize actions, and estimate the likely outcome of future actions. The Construct would provide a basis for some experimental management actions to improve understanding of key uncertainties and, thus, the ability to implement future actions to achieve recovery.

Long-term actions identified or evaluated in the biological assessment as potentially of benefit to listed species include ongoing studies evaluating the feasibility of lower Snake River actions, such as dam breaching, and the John Day phase 1 report that addresses juvenile fish passage alternatives (Corps, 2000c). Various actions under consideration to improve TDG and temperature conditions for the benefit of anadromous and resident species are also described, as well as various system modifications, including new turbine designs, surface bypass/collectors, and improved transport facilities. Changes in storage project operations and configurations in the Snake and lower Columbia rivers for the benefit of anadromous and resident fish (e.g., gas abatement and increased flow augmentation) are also described.

The Action Agencies' Construct is based on establishing an overall recovery goal. It would provide a method of defining desired levels of improvement in habitat, harvest, hatcheries, and hydropower, developing performance standards associated with these levels of improvement, evaluating and setting priorities for possible actions in each area, and selecting the most appropriate combination of actions for each category. The Action Agencies propose to use this method to evaluate possible future hydro actions, recognizing that overall recovery goals and associated obligations for survival improvements among all the categories may not be established within the timeframe of the FCRPS consultation. Accordingly, the Action Agencies recommend that interim performance standards be developed during consultation to enhance decision-making and to provide a model for developing performance standards for all four areas.

3.3 ISSUANCE OF SECTION 10 PERMIT FOR JUVENILE FISH TRANSPORTATION PROGRAM BY NMFS

During 1999, the Corps' Walla Walla District applied to NMFS for a new Section 10 permit for the JFT. As an interim measure, NMFS extended the Corps' existing Permit 895 under authority of Section 10 of the ESA and NMFS regulations governing ESA-listed fish and wildlife permits (50 CFR parts 217 through 227). The extended permit is valid until December 31, 2000, or until replaced by the new permit. The Corps is conducting a feasibility study, in conjunction with this consultation, to evaluate several alternatives to juvenile fish transportation. The extension of Permit 895 allows the duration of the permit to coincide with this reinitiation of ESA Section 7 consultation on the long-term management strategy for the FCRPS. Permit 895 authorizes the Corps' annual direct takes of juvenile endangered SR sockeye salmon, juvenile threatened SR spring/summer chinook salmon (naturally produced and artificially propagated), juvenile threatened SR fall chinook salmon, and juvenile endangered UCR steelhead (naturally produced and artificially propagated). All are associated with the Corps' JFT at four hydroelectric projects on the Snake and Columbia rivers (Lower Granite, Little Goose, Lower Monumental, and McNary). Permit 895 also authorizes the Corps' annual incidental takes of ESA-listed adult fish associated with fallbacks through the juvenile fish bypass systems at the four dams. With regard to the Corps' request to include an annual take of adult and juvenile endangered UCR spring chinook salmon, NMFS determined that any take of this species associated with Corps transportation activities would be incidental under the existing requirement to suspend transportation operations from McNary Dam during the spring migration period.

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4.0 BIOLOGICAL INFORMATION

4.1 LIFE HISTORIES, FACTORS FOR DECLINE, AND CURRENT RANGEWIDE STATUS

NMFS published the information in this section previously as Appendix A to the paper "A Standardized Quantitative Analysis of the Risks Faced by Salmonids in the Columbia River Basin" (McClure et al. 2000a). Additional details regarding the life histories, factors for decline, and current rangewide status of these species are found in Appendix C of this biological opinion.

4.1.1 Snake River Spring/Summer Chinook Salmon

4.1.1.1 Geographic Boundaries and Spatial Distribution

The location, geology, and climate of the Snake River region create a unique aquatic ecosystem for chinook salmon. Spring- and/or summer-run chinook salmon are found in several subbasins of the Snake River (CBFWA 1990). Of these, the Grande Ronde and Salmon rivers are large, complex systems composed of several smaller tributaries that are further composed of many small streams. In contrast, the Tucannon and Imnaha rivers are small systems with most salmon production in the main river. In addition to these major subbasins, three small streams (Asotin, Granite, and Sheep creeks) that enter the Snake River between Lower Granite and Hells Canyon dams provide small spawning and rearing areas (CBFWA 1990). Although there are some indications that multiple ESUs may exist within the Snake River basin, the available data do not clearly demonstrate their existence or define their boundaries. Because of compelling genetic and life-history evidence that fall chinook salmon are distinct from other chinook salmon in the Snake River, however, they are considered a separate ESU.

4.1.1.2 Historical Information

Historically, spring and/or summer chinook salmon spawned in virtually all accessible and suitable habitat in the Snake River system (Evermann 1895; Fulton 1968). During the late 1800s, the Snake River produced a substantial fraction of all Columbia River basin spring and summer chinook salmon, with total production probably exceeding 1.5 million in some years. By the mid-1900s, the abundance of adult spring and summer chinook salmon had greatly declined. Fulton (1968) estimated that an average of 125,000 adults per year entered the Snake River tributaries from 1950 through 1960. As evidenced by adult counts at dams, however, spring and summer chinook salmon have declined considerably since the 1960s (Corps 1989).

4.1.1.3 Life History

In the Snake River, spring and summer chinook share key life history traits. Both are stream-type fish, with juveniles that migrate swiftly to sea as yearling smolts. Depending primarily on location within the basin (and not on run type), adults tend to return after either 2 or 3 years in the ocean. Both spawn and rear in small, high-elevation streams (Chapman et al. 1991), although where the two forms coexist, spring-run chinook spawn earlier and at higher elevations than summer-run chinook.

4.1.1.4 Habitat and Hydrology

Even before mainstem dams were built, habitat was lost or severely damaged in small tributaries by construction and operation of irrigation dams and diversions, inundation of spawning areas by impoundments, and siltation and pollution from sewage, farming, logging, and mining (Fulton 1968). Recently, the construction of hydroelectric and water storage dams without adequate provision for adult and juvenile passage in the upper Snake River has kept fish from all spawning areas upstream of Hells Canyon Dam.

4.1.1.5 Hatchery Influence

There is a long history of human efforts to enhance production of chinook salmon in the Snake River basin through supplementation and stock transfers. The evidence is mixed as to whether these efforts have altered the genetic makeup of indigenous populations. Straying rates appear to be very low.

4.1.1.6 Population Trends and Risks

For the SR spring/summer chinook salmon ESU as a whole, NMFS estimates that the median population growth rate (lambda) over the base period[1] ranges from 0.96 to 0.80, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to the effectiveness of fish of wild origin (Tables B-2a and B-2b in McClure et al. 2000b). NMFS has also estimated median population growth rates and the risk of absolute extinction for the seven spring/summer chinook salmon index stocks,[2] using the same range of assumptions about the relative effectiveness of hatchery fish. At the low end, assuming that hatchery fish spawning in the wild have not reproduced (i.e., hatchery effectiveness = 0), the risk of absolute extinction within 100 years for the wild component ranges from zero for Johnson Creek to 0.78 for the Imnaha River (Table B-5 in McClure et al. 2000b). At the high end, assuming that the hatchery fish spawning

[1] Estimates of median population growth rate, risk of extinction, and the likelihood of meeting recovery goals are based on population trends observed during a base period beginning in 1980 and including 1999 adult returns. Population trends are projected under the assumption that all conditions will stay the same into the future.

[2] McClure et al. (2000c) have calculated population trend parameters for additional SR spring/summer chinook salmon stocks.

in the wild have been as productive as wild-origin fish (hatchery effectiveness = 100%), the risk of absolute extinction within 100 years ranges from zero for Johnson Creek to 1.00 for the wild component in the Imnaha River (Table B-6 in McClure et al. 2000b).

4.1.2 Snake River Fall Chinook Salmon

4.1.2.1 Geographic Boundaries and Spatial Distribution

The Snake River basin drains an area of approximately 280,000 km^2 and incorporates a range of vegetative life zones, climatic regions, and geological formations, including the deepest canyon (Hells Canyon) in North America. The ESU includes the mainstem river and all tributaries, from their confluence with the Columbia River to the Hells Canyon complex. Because genetic analyses indicate that fall-run chinook salmon in the Snake River are distinct from the spring/summer-run in the Snake basin (Waples et al. 1991), SR fall chinook salmon are considered separately from the other two forms. They are also considered separately from those assigned to the UCR summer- and fall-run ESU because of considerable differences in habitat characteristics and adult ocean distribution and less definitive, but still significant, genetic differences. There is, however, some concern that recent introgression from Columbia River hatchery strays is causing the Snake River population to lose the qualities that made it distinct for ESA purposes.

4.1.2.2 Historical Information

SR fall chinook salmon remained stable at high levels of abundance through the first part of the twentieth century, but then declined substantially. Although the historical abundance of fall chinook salmon in the Snake River is difficult to estimate, adult returns appear to have declined by three orders of magnitude since the 1940s, and perhaps by another order of magnitude from pristine levels. Irving and Bjornn (1981) estimated that the mean number of fall chinook salmon returning to the Snake River declined from 72,000 during the period 1938 to 1949 to 29,000 during the 1950s. Further declines occurred upon completion of the Hells Canyon complex, which blocked access to primary production areas in the late 1950s (see below).

4.1.2.3 Life History

Fall chinook salmon in this ESU are ocean-type. Adults return to the Snake River at ages 2 through 5, with age 4 most common at spawning (Chapman et al. 1991). Spawning, which takes place in late fall, occurs in the mainstem and in the lower parts of major tributaries (NWPPC 1989; Bugert et al. 1990). Juvenile fall chinook salmon move seaward slowly as subyearlings, typically within several weeks of emergence (Chapman et al. 1991). Based on modeling by the Chinook Technical Committee, the Pacific Salmon Commission estimates that a significant proportion of the SR fall chinook (about 36%) are taken in Alaska and Canada, indicating a far-ranging ocean distribution. In recent years, only 19% were caught off Washington, Oregon, and California, with the balance (45%) taken in the Columbia River (Simmons 2000).

4.1.2.4 Habitat and Hydrology

With hydrosystem development, the most productive areas of the Snake River basin are now inaccessible or inundated. The upper reaches of the mainstem Snake River were the primary areas used by fall chinook salmon, with only limited spawning activity reported downstream from river kilometer (Rkm) 439. The construction of Brownlee Dam (1958; Rkm 459), Oxbow Dam (1961; Rkm 439), and Hells Canyon Dam (1967; Rkm 397) eliminated the primary production areas of SR fall chinook salmon. There are now 12 dams on the mainstem Snake River, and they have substantially reduced the distribution and abundance of fall chinook salmon (Irving and Bjornn 1981).

4.1.2.5 Hatchery Influence

The Snake River has contained hatchery-reared fall chinook salmon since 1981 (Busack 1991). The hatchery contribution to Snake River escapement has been estimated at greater than 47 percent (Myers et al. 1998). Artificial propagation is recent, so cumulative genetic changes associated with it may be limited. Wild fish are incorporated into the brood stock each year, which should reduce divergence from the wild population. Release of subyearling fish may also help minimize the differences in mortality patterns between hatchery and wild populations that can lead to genetic change (Waples 1999). (See NMFS [1999a] for further discussion of the SR fall chinook salmon supplementation program.)

4.1.2.6 Other

Some SR fall chinook historically migrated over 1,500 km from the ocean. Although the Snake River population is now restricted to habitat in the lower river, genes associated with the lengthier migration may still reside in the population. Because longer freshwater migrations in chinook salmon tend to be associated with more-extensive oceanic migrations (Healey 1983), maintaining populations occupying habitat that is well inland may be important in continuing diversity in the marine ecosystem as well.

4.1.2.7 Population Trends and Risks

For the SR fall chinook salmon ESU as a whole, NMFS estimates that the median population growth rate (lambda) over the base period[3] ranges from 0.94 to 0.86, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (Tables B-2a and B-2b in McClure et al. 2000b). NMFS has also estimated the risk of absolute extinction for the aggregate SR fall chinook salmon population, using the same range of assumptions about the relative effectiveness of hatchery fish. At the low end, assuming that

[3] Estimates of median population growth rate, risk of extinction, and the likelihood of meeting recovery goals are based on population trends observed during a base period beginning in 1980 and including 1996 adult returns. Population trends are projected under the assumption that all conditions will stay the same into the future.

hatchery fish spawning in the wild have not reproduced (i.e., hatchery effectiveness = 0), the risk of absolute extinction within 100 years is 0.40 (Table B-5 in McClure et al. 2000b). At the high end, assuming that the hatchery fish spawning in the wild have been as productive as wild-origin fish (hatchery effectiveness = 100%), the risk of absolute extinction within 100 years is 1.00 (Table B-6 in McClure et al. 2000b).

4.1.3 Upper Columbia River Spring-run Chinook Salmon

4.1.3.1 Geographic Boundaries and Spatial Distribution

This ESU includes spring-run chinook populations found in Columbia River tributaries between the Rock Island and Chief Joseph dams, notably the Wenatchee, Entiat, and Methow River basins. The populations are genetically and ecologically separate from the summer- and fall-run populations in the lower parts of many of the same river systems (Myers et al. 1998). Although fish in this ESU are genetically similar to spring chinook in adjacent ESUs (i.e., mid-Columbia and Snake), they are distinguished by ecological differences in spawning and rearing habitat preferences. For example, spring-run chinook in upper Columbia tributaries spawn at lower elevations (500 to 1,000 m) than in the Snake and John Day River systems.

4.1.3.2 Historical Information

The upper Columbia River populations were intermixed during the Grand Coulee Fish Maintenance Project (1939 through 1943), resulting in loss of genetic diversity between populations in the ESU. Homogenization remains an important feature of the ESU. Fish abundance has trended downward both recently and over the long term. At least six former populations from this ESU are now extinct, and nearly all extant populations have fewer than 100 wild spawners.

4.1.3.3 Life History (Including Ocean)

UCR spring chinook are considered stream-type fish, with smolts migrating as yearlings. Most stream-type fish mature at 4 years of age. Few coded-wire tags are recovered in ocean fisheries, suggesting that the fish move quickly out of the north central Pacific and do not migrate along the coast.

4.1.3.4 Habitat and Hydrology

Spawning and rearing habitat in the Columbia River and its tributaries upstream of the Yakima River includes dry areas where conditions are less conducive to steelhead survival than in many other parts of the Columbia basin (Mullan et al. 1992a). Salmon in this ESU must pass up to nine Federal and private dams, and Chief Joseph Dam prevents access to historical spawning grounds farther upstream. Degradation of remaining spawning and rearing habitat continues to be a major concern associated with urbanization, irrigation projects, and livestock grazing along riparian corridors. Overall harvest rates are low for this ESU, currently less than 10% (ODFW and WDFW 1995).

4.1.3.5 Hatchery Influence

Spring-run chinook salmon from the Carson National Fish Hatchery (a large composite, non-native stock) were introduced into and have been released from local hatcheries (Leavenworth, Entiat, and Winthrop National Fish Hatcheries [NFH]). Little evidence suggests that these hatchery fish stray into wild areas or hybridize with naturally spawning populations. In addition to these national production hatcheries, two supplementation hatcheries are operated by the WDFW in this ESU. The Methow Fish Hatchery Complex (operations began in 1992) and the Rock Island Fish Hatchery Complex (operations began in 1989) were both designed to implement supplementation programs for naturally spawning populations on the Methow and Wenatchee rivers, respectively (Chapman et al. 1995).

4.1.3.6 Population Trends and Risks

For the UCR spring chinook salmon ESU as a whole, NMFS estimates that the median population growth rate (lambda) over the base period[4] ranges from 0.85 to 0.83, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (Tables B-2a and B-2b in McClure et al. 2000b). NMFS has also estimated median population growth rates and the risk of absolute extinction for the three spawning populations identified by Ford et al. (1999), using the same range of assumptions about the relative effectiveness of hatchery fish. At the low end, assuming that hatchery fish spawning in the wild have not reproduced (i.e., hatchery effectiveness = 0), the risk of absolute extinction within 100 years ranges from 0.97 for the Methow River to 1.00 for the Methow and Entiat rivers (Table B-5 in McClure et al. 2000b). At the high end, assuming that the hatchery fish spawning in the wild have been as productive as wild-origin fish (hatchery effectiveness = 100%), the risk of extinction within 100 years is 1.00 for all three spawning populations (Table B-6 in McClure et al. 2000b).

NMFS has also used population risk assessments for UCR spring chinook salmon and steelhead ESUs from the draft QAR (Cooney 2000). Risk assessments described in that report were based on Monte Carlo simulations with simple spawner/spawner models that incorporate estimated smolt carrying capacity. Population dynamics were simulated for three separate spawning populations in the UCR spring chinook salmon ESU, the Wenatchee, Entiat, and Methow populations. The QAR assessments showed extinction risks for UCR spring chinook salmon of 50% for the Methow, 98% for the Wenatchee, and 99% for the Entiat spawning populations.

[4] Estimates of median population growth rate, risk of extinction, and the likelihood of meeting recovery goals are based on population trends observed during a base period beginning in 1980 and including 1998 adult returns. Population trends are projected under the assumption that all conditions will stay the same into the future.

These estimates are based on the assumption that the median return rate for the 1980 brood year to the 1994 brood year series will continue into the future.

4.1.4 Upper Willamette River Chinook Salmon

4.1.4.1 Geographic Boundaries and Spatial Distribution

The UWR chinook ESU includes native spring-run populations above Willamette Falls and in the Clackamas River. In the past, it included sizable numbers of spawning salmon in the Santiam River, the middle fork of the Willamette River, and the McKenzie River, as well as smaller numbers in the Molalla River, Calapooia River, and Albiqua Creek. Although the total number of fish returning to the Willamette has been relatively high (24,000), about 4,000 fish now spawn naturally in the ESU, two-thirds of which originate in hatcheries. The McKenzie River supports the only remaining naturally reproducing population in the ESU (ODFW 1998d).

4.1.4.2 Historical Information

There are no direct estimates of the size of the chinook salmon runs in the Willamette River basin before the 1940s. McKernan and Mattson (1950) present anecdotal information that the native American fishery at the Willamette Falls may have yielded 2,000,000 lb (908,000 kg) of salmon (454,000 fish, each weighing 20 lb [9.08 kg]). Based on egg collections at salmon hatcheries, Mattson (1948) estimates that the spring chinook salmon run in the 1920s may have been 5 times the run size of 55,000 fish in 1947, or 275,000 fish. Much of the early information on salmon runs in the upper Willamette River basin comes from operation reports of state and Federal hatcheries.

4.1.4.3 Life History

Fish in this ESU are distinct from those of adjacent ESUs in life history and marine distribution. The life history of chinook salmon in the Upper Willamette River ESU includes traits from both ocean- and stream-type development strategies. Coded-wire-tag (CWT) recoveries indicate that the fish travel to the marine waters off British Columbia and Alaska. More Willamette fish are, however, recovered in Alaskan waters than fish from the Lower Columbia River ESU. UWR chinook mature in their fourth or fifth years. Historically, 5-year-old fish dominated the spawning migration runs; recently, however, most fish have matured at age 4. The timing of the spawning migration is limited by Willamette Falls. High flows in the spring allow access to the upper Willamette basin, whereas low flows in the summer and autumn prevent later-migrating fish from ascending the falls. The low flows may serve as an isolating mechanism, separating this ESU from others nearby.

4.1.4.4 Habitat and Hydrology

Human activities have had enormous effects on the salmonid populations in the Willamette drainage. First, the Willamette River, once a highly braided river system, has been dramatically simplified through channelization, dredging, and other activities that have reduced rearing habitat (i.e., stream shoreline) by as much as 75%. In addition, the construction of 37 dams in the basin has blocked access to over 700 km of stream and river spawning habitat. The dams also alter the temperature regime of the Willamette and its tributaries, affecting the timing of development of naturally spawned eggs and fry. Water quality is also affected by development and other economic activities. Agricultural and urban land uses on the valley floor, as well as timber harvesting in the Cascade and Coast ranges, contribute to increased erosion and sediment load in Willamette basin streams and rivers. Finally, since at least the 1920s, the lower Willamette has suffered municipal and industrial pollution.

4.1.4.5 Hatchery Influence

Hatchery production in the basin began in the late nineteenth century. Eggs were transported throughout the basin, resulting in current populations that are relatively homogeneous genetically (although still distinct from those of surrounding ESUs). Hatchery production continues in the Willamette, with an average of 8.4 million smolts and fingerlings released each year into the main river or its tributaries between 1975 and 1994. Hatcheries are currently responsible for most production (90% of escapement) in the basin.

The Clackamas River currently accounts for about 20% of the production potential in the Willamette River basin, originating from one hatchery plus natural production areas that are primarily located above the North Fork Dam. The interim escapement goal for the area above North Fork Dam is 2,900 fish (ODFW 1998c). However, the system is so heavily influenced by hatchery production that it is difficult to distinguish spawners of natural stock from hatchery origin fish. Approximately 1,000 to 1,500 adults have been counted at the North Fork Dam in recent years.

4.1.4.6 Other

Harvest on this ESU is high, both in the ocean and inriver. The total inriver harvest below the falls from 1991 through 1995 averaged 33% and was much higher before then. Ocean harvest was estimated as 16% for 1982 through 1989. ODFW (1998b) indicates that total (marine and freshwater) harvest rates on UWR spring-run stocks were reduced considerably for the 1991 through 1993 brood years, to an average of 21%.

4.1.4.7 Population Trends and Risks

For the UWR chinook salmon ESU as a whole, NMFS estimates that the median population growth rate (lambda) over the base period[5] ranges from 1.01 to 0.63, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (Tables B-2a and B-2b in McClure et al. 2000b). NMFS has also estimated the risk of absolute extinction for the aggregate UWR chinook salmon population in the McKenzie River, above Leaburg, using the same range of assumptions about the relative effectiveness of hatchery fish. At the low end, assuming that hatchery fish spawning in the wild have not reproduced (i.e., hatchery effectiveness = 0), the risk of absolute extinction within 100 years is 0.01 (Table B-5 in McClure et al. 2000b). At the high end, assuming that the hatchery fish spawning in the wild have been as productive as wild-origin fish (hatchery effectiveness = 100%), the risk of absolute extinction within 100 years is 0.85 (Table B-6 in McClure et al. 2000b).

4.1.5 Lower Columbia River Chinook Salmon

4.1.5.1 Geographic Boundaries and Spatial Distribution

The Lower Columbia River ESU is characterized by numerous short- and medium-length rivers that drain the coast ranges and the west slope of the Cascade Mountains. This ESU includes all native populations from the mouth of the Columbia River to the crest of the Cascade Range, excluding populations above Willamette Falls. The former location of Celilo Falls (drowned by The Dalles reservoir in 1960) is the eastern boundary for this ESU. Stream-type, spring-run chinook salmon found in the Klickitat River or the introduced Carson spring-chinook salmon strain are not included in this ESU. Spring-run chinook salmon in the Sandy River have been influenced by spring-run chinook salmon introduced from the Willamette River ESU. However, analyses suggest that considerable genetic resources still reside in the existing population (Meyers et al. 1998). Recent escapements above Marmot Dam on the Sandy River average 2,800 and have been increasing (ODFWa).

Tule fall chinook from the LCR chinook salmon ESU were observed spawning in the Ives Island area during October 1999. The Hardy/Hamilton creeks/Ives Island complex is located along the Washington shoreline approximately 2 miles below Bonneville Dam.

4.1.5.2 Historical Information

Historical records of chinook salmon abundance are sparse, but cannery records suggest a peak run of 4.6 million fish in 1883. Although fall-run chinook salmon are still present throughout much of their historical range, most of the fish spawning today are first-generation hatchery

[5] Estimates of median population growth rate, risk of extinction, and the likelihood of meeting recovery goals are based on population trends observed during a base period beginning in 1980 and including 1998 adult returns. Population trends are projected under the assumption that all conditions will stay the same into the future.

strays. Furthermore, spring-run populations have been severely depleted throughout the ESU and extirpated from several rivers.

4.1.5.3 Life History

Most fall-run fish in the LCR chinook salmon ESU emigrate to the marine environment as subyearlings (Reimers and Loeffel 1967, Howell et al. 1985, WDF et al. 1993). Returning adults that emigrated as yearling smolts may have originated from the extensive hatchery programs in the ESU. It is also possible that modifications in the river environment have altered the duration of freshwater residence. CWT recoveries of Lower Columbia River ESU fish suggest a northerly migration route, but (based on CWT recoveries) the fish contribute more to fisheries off British Columbia and Washington than to the Alaskan fishery. Tule fall chinook salmon return at adult ages 3 and 4; "bright" fall chinook return at ages 4 and 5, with significant numbers returning at age 6. Tule and bright chinook salmon are distinct in their spawn timing.

4.1.5.4 Habitat and Hydrology

As in other ESUs, chinook salmon have been affected by the alteration of freshwater habitat (Bottom et al. 1985, WDF et al. 1993, Kostow 1995). Timber harvesting and associated road building peaked in the 1930s, but effects from the timber industry remain (Kostow 1995). Agriculture is widespread in this ESU and has affected riparian vegetation and stream hydrology. The ESU is also highly affected by urbanization, including river diking and channelization, wetland draining and filling, and pollution (Kostow 1995).

4.1.5.5 Hatchery Influence

The Lower Columbia River ESU has been subject to intensive hatchery influence. Hatchery programs to enhance chinook salmon fisheries in the lower Columbia River began in the 1870s, releasing billions of fish over time. That equals the total hatchery releases for all other chinook ESUs combined (Myers et al. 1998). Although most of the stocks have come from inside the ESU, more than 200 million fish from outside the ESU have been released since 1930 (Myers et al. 1998).

4.1.5.6 Population Trends and Risks

For the LCR chinook salmon ESU as a whole, NMFS estimates that the median population growth rate (lambda) over the base period[6] ranges from 0.98 to 0.88, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild

[6] Estimates of median population growth rate, risk of extinction, and the likelihood of meeting recovery goals are based on population trends observed during a base period beginning in 1980 and including 1997 adult returns for most spawning aggregations. Population trends are projected under the assumption that all conditions will stay the same into the future.

origin (Tables B-2a and B-2b in McClure et al. 2000b). NMFS estimated the risk of absolute extinction for nine spawning aggregations,[7] using the same range of assumptions about the relative effectiveness of hatchery fish. At the low end, assuming that hatchery fish spawning in the wild have not reproduced (i.e., hatchery effectiveness = 0), the risk of absolute extinction within 100 years ranges from zero for the Sandy River late run and Big Creek to 1.00 for Mill Creek (Table B-5 in McClure et al. 2000b). At the high end, assuming that the hatchery fish spawning in the wild have been as productive as wild-origin fish (hatchery effectiveness = 100%), the risk of absolute extinction within 100 years is $\geq$0.99 for all but one of nine spawning aggregations (zero for the Sandy River late run; Table B-6 in McClure et al. 2000b).

4.1.6 Snake River Steelhead

4.1.6.1 Geographic Boundaries and Spatial Distribution

Steelhead spawning habitat in the Snake River is distinctive in having large areas of open, low-relief streams at high elevations. In many Snake River tributaries, spawning occurs at a higher elevation (up to 2,000 m) than for steelhead in any other geographic region. SR steelhead also migrate farther from the ocean (up to 1,500 km) than most.

4.1.6.2 Historical Information

No estimates of historical (pre-1960s) abundance specific to this ESU are available.

4.1.6.3 Life History (Including Ocean)

Fish in this ESU are summer steelhead. They enter freshwater from June to October and spawn during the following March to May. Two groups are identified, based on migration timing, ocean-age, and adult size. A-run steelhead, thought to be predominately age-1-ocean, enter freshwater during June through August. B-run steelhead, thought to be age-2-ocean, enter freshwater during August through October. B-run steelhead typically are 75 to 100 mm longer at the same age. Both groups usually smolt as 2- or 3-year-olds (Whitt 1954, BPA 1992, Hassemer 1992). All steelhead are iteroparous, capable of spawning more than once before death.

4.1.6.4 Habitat and Hydrology

Hydrosystem projects create substantial habitat blockages in this ESU; the major ones are the Hells Canyon Dam complex (mainstem Snake River) and Dworshak Dam (North Fork Clearwater River). Minor blockages are common throughout the region. Steelhead spawning areas have been degraded by overgrazing, as well as by historical gold dredging and sedimentation due to poor land management. Habitat in the Snake basin is warmer and drier and often more eroded than elsewhere in the Columbia River basin or in coastal areas.

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[7] McClure et al. (2000c) have calculated population trend parameters for additional LCR chinook salmon stocks.

4.1.6.5 Hatchery Influence

Hatchery fish are widespread and stray to spawn naturally throughout the region. In the 1990s, an average of 86% of adult steelhead passing Lower Granite Dam were of hatchery origin. Hatchery contribution to naturally spawning populations varies, however, across the region. Hatchery fish dominate some stocks, but do not contribute to others.

4.1.6.6 Population Trends and Risks

For the SR steelhead ESU as a whole, NMFS estimates that the median population growth rate (lambda) over the base period[8] ranges from 0.91 to 0.70, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (Tables B-2a and B-2b in McClure et al. 2000b). NMFS has also estimated the risk of absolute extinction for the A- and B-runs, using the same range of assumptions about the relative effectiveness of hatchery fish. At the low end, assuming that hatchery fish spawning in the wild have not reproduced (i.e., hatchery effectiveness = 0), the risk of absolute extinction within 100 years is 0.01 for A-run steelhead and 0.93 for B-run fish (Table B-5 in McClure et al. 2000b). At the high end, assuming that the hatchery fish spawning in the wild have been as productive as wild-origin fish (hatchery effectiveness = 100%), the risk of absolute extinction within 100 years is 1.00 for both runs (Table B-6 in McClure et al. 2000b).

4.1.7 Upper Columbia River Steelhead

4.1.7.1 Geographic Boundaries and Spatial Distribution

This ESU occupies the Columbia River basin upstream of the Yakima River. Rivers in the area primarily drain the east slope of the northern Cascade Mountains and include the Wenatchee, Entiat, Methow, and Okanogan River basins. The climate of the area reaches temperature and precipitation extremes; most precipitation falls as mountain snow (Mullan et al. 1992b). The river valleys are deeply dissected and maintain low gradients, except for the extreme headwaters (Franklin and Dyrness 1973).

4.1.7.2 Historical Information

Estimates of historical (pre-1960s) abundance specific to this ESU are available from fish counts at dams. Counts at Rock Island Dam from 1933 to 1959 averaged 2,600 to 3,700, suggesting a prefishery run size exceeding 5,000 adults for tributaries above Rock Island Dam (Chapman et al. 1994). Runs may, however, already have been depressed by lower Columbia River fisheries.

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[8] Estimates of median population growth rate, risk of extinction, and the likelihood of meeting recovery goals are based on population trends observed during a base period beginning in 1980 and including 1997 adult returns. Population trends are projected under the assumption that all conditions will stay the same into the future.

4.1.7.3 Life History

As in other inland ESUs (the Snake and mid-Columbia River basins), steelhead in the Upper Columbia River ESU remain in freshwater up to a year before spawning. Smolt age is dominated by 2-year-olds. Based on limited data, steelhead from the Wenatchee and Entiat rivers return to freshwater after 1 year in salt water, whereas Methow River steelhead are primarily age-2-ocean (Howell et al. 1985). Life history characteristics for UCR steelhead are similar to those of other inland steelhead ESUs; however, some of the oldest smolt ages for steelhead, up to 7 years, are reported from this ESU. The relationship between anadromous and nonanadromous forms in the geographic area is unclear.

4.1.7.4 Habitat and Hydrology

The Chief Joseph and Grand Coulee dam construction caused blockages of substantial habitat, as did that of smaller dams on tributary rivers. Habitat issues for this ESU relate mostly to irrigation diversions and hydroelectric dams, as well as to degraded riparian and instream habitat from urbanization and livestock grazing.

4.1.7.5 Hatchery Influence

Hatchery fish are widespread and escape to spawn naturally throughout the region. Spawning escapement is dominated by hatchery-produced fish.

4.1.7.6 Population Trends and Risks

For the UCR steelhead ESU as a whole, NMFS estimates that the median population growth rate (lambda) over the base period[9] ranges from 0.94 to 0.66, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (Tables B-2a and B-2b in McClure et al. 2000b). NMFS has also estimated the risk of absolute extinction for the aggregate UCR steelhead population, using the same range of assumptions about the relative effectiveness of hatchery fish. At the low end, assuming that hatchery fish spawning in the wild have not reproduced (i.e., hatchery effectiveness = 0), the risk of absolute extinction within 100 years is 0.25 (Table B-5 in McClure et al. 2000b). Assuming that the hatchery fish spawning in the wild have been as productive as wild-origin fish (hatchery effectiveness = 100%), the risk of absolute extinction within 100 years is 1.00 (Table B-6 in McClure et al. 2000b).

Because of data limitations, the QAR steelhead assessments in Cooney (2000) were limited to two aggregate spawning groups—the Wenatchee/Entiat composite and the above-Wells populations. Wild production of steelhead above Wells Dam was assumed to be limited to the

[9] Estimates of median population growth rate, risk of extinction, and the likelihood of meeting recovery goals are based on population trends observed during a base period beginning in 1980 and including 1996 adult returns. Population trends are projected under the assumption that all conditions will stay the same into the future.

Methow system. Assuming a relative effectiveness of hatchery spawners of 1.0, the risk of absolute extinction within 100 years for UCR steelhead is 100%. The QAR also assumed hatchery effectiveness values of 0.25 and 0.75. A hatchery effectiveness of 0.25 resulted in projected risks of extinction of 35% for the Wenatchee/Entiat and 28% for the Methow populations. At a hatchery effectiveness of 0.75, risks of 100% were projected for both populations.

4.1.8 Middle Columbia River Steelhead

4.1.8.1 Geographic Boundaries and Spatial Distribution

The Middle Columbia River ESU occupies the Columbia River basin from above the Wind River in Washington and the Hood River in Oregon and continues upstream to include the Yakima River, Washington. The region includes some of the driest areas of the Pacific Northwest, generally receiving less than 40 cm of precipitation annually (Jackson 1993). Summer steelhead are widespread throughout the ESU; winter steelhead occur in Mosier, Chenowith, Mill, and Fifteenmile creeks, Oregon, and in the Klickitat and White Salmon rivers, Washington. The John Day River probably represents the largest native, natural spawning stock of steelhead in the region.

4.1.8.2 Historical Information

Estimates of historical (pre-1960s) abundance specific to this ESU are available for the Yakima River, which has an estimated run size of 100,000 (WDF et al. 1993). Assuming comparable run sizes for other drainage areas in this ESU, the total historical run size may have exceeded 300,000 steelhead.

4.1.8.3 Life History

Most fish in this ESU smolt at 2 years and spend 1 to 2 years in salt water before reentering freshwater, where they may remain up to a year before spawning (Howell et al. 1985, BPA 1992). All steelhead upstream of The Dalles Dam are summer-run (Schreck et al. 1986, Reisenbichler et al. 1992, Chapman et al. 1994). The Klickitat River, however, produces both summer and winter steelhead, and age-2-ocean steelhead dominate the summer steelhead, whereas most other rivers in the region produce about equal numbers of both age-1- and 2-ocean fish. A nonanadromous form co-occurs with the anadromous form in this ESU; information suggests that the two forms may not be isolated reproductively, except where barriers are involved.

4.1.8.4 Habitat and Hydrology

The only substantial habitat blockage now present in this ESU is at Pelton Dam on the Deschutes River, but minor blockages occur throughout the region. Water withdrawals and overgrazing have seriously reduced summer flows in the principal summer steelhead spawning and rearing tributaries of the Deschutes River. This is significant because high summer and low winter temperatures are limiting factors for salmonids in many streams in this region (Bottom et al. 1985).

4.1.8.5 Hatchery Influence

Continued increases in the proportion of stray steelhead in the Deschutes River basin is a major concern. The ODFW and the Confederated Tribes of the Warm Springs Reservation of Oregon (CTWSRO) estimate that 60% to 80% of the naturally spawning population consists of strays, which greatly outnumber naturally produced fish. Although the reproductive success of stray fish has not been evaluated, their numbers are so high that major genetic and ecological effects on natural populations are possible (Busby et al. 1999).

The negative effects of any interbreeding between stray and native steelhead will be exacerbated if the stray steelhead originated in geographically distant river basins, especially if the river basins are in different ESUs. The populations of steelhead in the Deschutes River basin include the following:

- Steelhead native to the Deschutes River
- Hatchery steelhead from the Round Butte Hatchery on the Deschutes River
- Wild steelhead strays from other rivers in the Columbia River basin
- Hatchery steelhead strays from other Columbia River basin streams

Regarding the latter, CTWSRO reports preliminary findings from a tagging study by T. Bjornn and M. Jepson (University of Idaho) and NMFS suggesting that a large fraction of the steelhead passing through Columbia River dams (e.g., John Day and Lower Granite dams) have entered the Deschutes River and then returned to the mainstem Columbia River. A key unresolved question about the large number of strays in the Deschutes basin is how many stray fish remain in the basin and spawn naturally.

4.1.8.6 Population Trends and Risks

For the MCR steelhead ESU as a whole, NMFS estimates that the median population growth rate (lambda) over the base period[10] ranges from 0.88 to 0.75, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (Tables B-2a and B-2b in McClure et al. 2000b). NMFS has also estimated the risk of absolute extinction for four of the spawning aggregations, using the same range of assumptions about the relative effectiveness of hatchery fish. At the low end, assuming that hatchery fish spawning in the wild

[10] Estimates of median population growth rate, risk of extinction, and the likelihood of meeting recovery goals are based on population trends observed during a base period that varies between spawning aggregations. Population trends are projected under the assumption that all conditions will stay the same into the future.

have not reproduced (i.e., hatchery effectiveness = 0), the risk of absolute extinction within 100 years ranges from zero for the Yakima River summer run to 1.00 for the Umatilla River and Deschutes River summer runs (Table B-5 in McClure et al. 2000b). Assuming that the hatchery fish spawning in the wild have been as productive as wild-origin fish (hatchery effectiveness = 100%), the risk of absolute extinction within 100 years ranges from zero for the Yakima River summer run to 1.00 for the Deschutes River summer run (Table B-6 in McClure et al. 2000b).

4.1.9 Upper Willamette River Steelhead

4.1.9.1 Geographic Boundaries and Spatial Distribution

The UWR steelhead ESU occupies the Willamette River and tributaries upstream of Willamette Falls, extending to and including the Calapooia River. These major river basins containing spawning and rearing habitat comprise more than 12,000 km^2 in Oregon. Rivers that contain naturally spawning winter-run steelhead include the Tualatin, Molalla, Santiam, Calapooia, Yamhill, Rickreall, Luckiamute, and Mary's, although the origin and distribution of steelhead in a number of these basins is being debated. Early migrating winter and summer steelhead have been introduced into the upper Willamette River basin, but those components are not part of the ESU.

4.1.9.2 Historical Information

Native winter steelhead within this ESU have been declining since 1971 and have exhibited large fluctuations in abundance.

4.1.9.3 Life History

In general, native steelhead of the upper Willamette River basin are late-migrating winter steelhead, entering freshwater primarily in March and April. This atypical run timing appears to be an adaptation for ascending Willamette Falls, which functions as an isolating mechanism for UWR steelhead. Reproductive isolation resulting from the falls may explain the genetic distinction between steelhead from the upper Willamette River basin and those in the lower river. UWR late-migrating steelhead are ocean-maturing fish. Most return at age 4, with a small proportion returning as 5-year-olds (Busby et al. 1996).

4.1.9.4 Habitat and Hydrology

Willamette Falls (Rkm 77) is a known migration barrier. Winter steelhead and spring chinook salmon historically occurred above the falls, whereas summer steelhead, fall chinook, and coho salmon did not. Detroit and Big Cliff dams cut off 540 km of spawning and rearing habitat in the North Santiam River. In general, habitat in this ESU has become substantially simplified since the 1800s by removal of large woody debris to increase the river's navigability.

4.1.9.5 Hatchery Influence

The main hatchery production of native (late-run) winter steelhead occurs in the North Fork Santiam River, where estimates of hatchery proportion in natural spawning areas range from 14% to 54% (Busby et al. 1996). More recent estimates of the percentage of naturally spawning fish attributable to hatcheries in the late 1990s are 24% in the Molalla, 17% in the North Santiam, 5% to 12% in the South Santiam, and less than 5% in the Calapooia (Chilcote 1997, 1998).

4.1.9.6 Population Trends and Risks

For the UWR steelhead ESU as a whole, NMFS estimates that the median population growth rate (lambda) over the base period[11] ranges from 0.94 to 0.87, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (Tables B-2a and B-2b in McClure et al. 2000b). NMFS has also estimated the risk of absolute extinction for four spawning aggregations, using the same range of assumptions about the relative effectiveness of hatchery fish. At the low end, assuming that hatchery fish spawning in the wild have not reproduced (i.e., hatchery effectiveness = 0), the risk of absolute extinction within 100 years ranges from zero for the South Santiam River to 0.74 for the Calapooia River (Table B-5 in McClure et al. 2000b). Assuming that the hatchery fish spawning in the wild have been as productive as wild-origin fish (hatchery effectiveness = 100%), the risk of absolute extinction within 100 years ranges from 0.74 for the Calapooia River to 1.00 for the Molalla River and South Santiam River spawning aggregations (Table B-6 in McClure et al. 2000b).

4.1.10 Lower Columbia River Steelhead

4.1.10.1 Geographic Boundaries and Spatial Distribution

The Lower Columbia River ESU encompasses all steelhead runs in tributaries between the Cowlitz and Wind rivers on the Washington side of the Columbia, and the Willamette and Hood rivers on the Oregon side. The populations of steelhead that make up the Lower Columbia River ESU are distinguished from adjacent populations by genetic and habitat characteristics. The ESU consists of summer and winter coastal steelhead runs in the tributaries of the Columbia River as it cuts through the Cascades. These populations are genetically distinct from inland populations (east of the Cascades), as well as from steelhead populations in the upper Willamette basin and coastal runs north and south of the Columbia River mouth. Not included in the ESU are runs in the Willamette River above Willamette Falls (Upper Willamette River ESU), runs in the Little and Big White Salmon rivers (Middle Columbia River ESU) and runs based on four imported hatchery stocks: early-spawning winter Chambers Creek/lower Columbia River mix, summer Skamania Hatchery stock, winter Eagle Creek NFH stock, and winter Clackamas River ODFW stock (63 FR 13351 and 13352). This area has at least 36 distinct runs (Busby et al.

[11] Estimates of median population growth rate, risk of extinction, and the likelihood of meeting recovery goals are based on population trends observed during a base period beginning in 1980 and including 1997 adult returns. Population trends are projected under the assumption that all conditions will stay the same into the future.

1996), 20 of which were identified in the initial listing petition. In addition, numerous small tributaries have historical reports of fish, but no current abundance data. The major runs in the ESU, for which there are estimates of run size, are the Cowlitz River winter runs, Toutle River winter runs, Kalama River winter and summer runs, Lewis River winter and summer runs, Washougal River winter and summer runs, Wind River summer runs, Clackamas River winter and summer runs, Sandy River winter and summer runs, and Hood River winter and summer runs.

4.1.10.2 Historical Information

For the larger runs, current counts have been in the range of one to 2,000 fish (Cowlitz, Kalama, and Sandy rivers); historical counts, however, put these runs at more than 20,000 fish. In general, all runs in the ESU have declined over the past 20 years, with sharp declines in the last 5 years.

4.1.10.3 Habitat and Hydrology

Steelhead in this ESU are thought to use estuarine habitats extensively during outmigration, smoltification, and spawning migrations. The lower reaches of the Columbia River are highly modified by urbanization and dredging for navigation. The upland areas covered by this ESU are extensively logged, affecting water quality in the smaller streams used primarily by summer runs. In addition, all major tributaries used by LCR steelhead have some form of hydraulic barrier that impedes fish passage. Barriers range from impassible structures in the Sandy River basin that block access to extensive, historically occupied, steelhead habitat, to passable but disruptive projects on the Cowlitz and Lewis rivers. The Biological Review Team (BRT 1997) viewed the overall effect of hydrosystem activities on this ESU as an important determinant of extinction risk.

4.1.10.4 Hatchery Influence

Many populations of steelhead in the Lower Columbia River ESU are dominated by hatchery escapement. Roughly 500,000 hatchery-raised steelhead are released into drainages within this ESU each year. As a result, first-generation hatchery fish are thought to make up 50% to 80% of the fish counted on natural spawning grounds. The effect of hatchery fish is not uniform, however. Several runs are mostly hatchery strays (e.g., the winter run in the Cowlitz River [92%] and the Kalama River [77%] and the summer run in the North Fork Washougal River [50%]), whereas others are almost free of hatchery influence (the summer run in the mainstem Washougal River [0%] and the winter runs in the North Fork Toutle and Wind rivers [0% to 1%]).

4.1.10.5 Other

Escapement estimates for the steelhead fishery in the Lower Columbia River ESU are based on inriver and estuary sport-fishing reports; there is a limited ocean fishery on this ESU. Harvest rates range from 20% to 50% on the total run, but for hatchery-wild differentiated stocks, harvest rates on wild fish have dropped to 0% to 4% in recent years (punch card data from WDFW through 1994).

4.1.10.6 Population Trends and Risks

For the LCR steelhead ESU as a whole, NMFS estimates that the median population growth rate (lambda) over the base period[12] ranges from 0.98 to 0.78, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (Tables B-2a and B-2b in McClure et al. 2000b). NMFS has also estimated the risk of absolute extinction for seven of the spawning aggregations, using the same range of assumptions about the relative effectiveness of hatchery fish. At the low end, assuming that hatchery fish spawning in the wild have not reproduced (i.e., hatchery effectiveness = 0), the risk of absolute extinction within 100 years ranges from zero for the Kalama River summer run and the Clackamas River and Kalama River winter runs to 1.00 for the Clackamas River summer run and the Toutle River winter run (Table B-5 in McClure et al. 2000b). Assuming that the hatchery fish spawning in the wild have been as productive as wild-origin fish (hatchery effectiveness = 100%), the risk of absolute extinction within 100 years rises to 1.00 for all but one population (the risk of extinction is 0.86 for the Green River winter run; Table B-6 in McClure et al. 2000b).

4.1.11 Columbia River Chum Salmon

4.1.11.1 Geographic Boundaries and Spatial Distribution

Chum salmon of the Columbia River ESU spawn in tributaries and in mainstem spawning areas below Bonneville Dam. Most fish spawn on the Washington side of the Columbia River (Johnson et al. 1997).

4.1.11.2 Historical Information

Previously, chum salmon were reported in almost every river in the lower Columbia River basin, but most runs disappeared by the 1950s (Rich 1942, Marr 1943, Fulton 1970). Currently, WDFW regularly monitors only a few natural populations in the basin, one in Grays River, two in small streams near Bonneville Dam, and the mainstem area next to one of the latter two streams.

4.1.11.3 Life History

[12] Estimates of median population growth rate, risk of extinction, and the likelihood of meeting recovery goals are based on population trends observed during a base period that varies between spawning aggregations. Population trends are projected under the assumption that all conditions will stay the same into the future.

Chum salmon enter the Columbia River from mid-October through early December and spawn from early November to late December. Recent genetic analysis of fish from Hardy and Hamilton creeks and from the Grays River indicate that these fish are genetically distinct from other chum salmon populations in Washington. Genetic variability within and between populations in several geographic areas is similar, and populations in Washington show levels of genetic subdivision typical of those seen between summer- and fall-run populations in other areas and typical of populations within run types (Salo 1991, WDF et al. 1993, Phelps et al. 1994, and Johnson et al. 1997).

4.1.11.4 Other

Historically, the CR chum salmon ESU supported a large commercial fishery, landing more than 500,000 fish per year. Commercial catches declined beginning in the mid-1950s. There are now no recreational or directed commercial fisheries for chum salmon in the Columbia River, although chum salmon are taken incidentally in the gill-net fisheries for coho and chinook salmon, and some tributaries have a minor recreational harvest (WDF et al. 1993).

4.1.11.5 Population Trends and Risks

Hatchery fish have had little influence on the wild component of the CR chum salmon ESU. NMFS estimates an median population growth rate (lambda) over the base period,[13] for the ESU as a whole, of 1.04 (Tables B-2a and B-2b in McClure et al. 2000b). Because census data are peak counts (and because the precision of those counts decreases markedly during the spawning season as water levels and turbidity rise), NMFS is unable to estimate the risk of absolute extinction for this ESU.

4.1.12 Snake River Sockeye Salmon

4.1.12.1 Geographic Boundaries and Spatial Distribution

The only remaining sockeye in the Snake River system are found in Redfish Lake, on the Salmon River. The nonanadromous form (kokanee), found in Redfish Lake and elsewhere in the Snake River basin, is included in the ESU.

[13] Estimates of median population growth rate, risk of extinction, and the likelihood of meeting recovery goals are based on population trends observed during a base period of 1980 through 1998 adult returns for the Grays River mainstem and the West Fork, Crazy Johnson, and Hamilton creek spawning aggregations, including the 1999 adult returns for Hardy Creek and Hamilton Springs. Population trends are projected under the assumption that all conditions will stay the same into the future.

4.1.12.2 Historical Information

Snake River sockeye were historically abundant in several lake systems of Idaho and Oregon. However, all populations have been extirpated in the past century, except fish returning to Redfish Lake.

4.1.12.3 Life History

In general, juvenile sockeye salmon rear in the lake environment for 1, 2, or 3 years before migrating to sea. Adults typically return to the natal lake system to spawn after spending 1, 2, 3, or 4 years in the ocean (Gustafson et al. 1997).

4.1.12.4 Habitat and Hydrology

In 1910, impassable Sunbeam Dam was constructed 20 miles downstream of Redfish Lake. Although several fish ladders and a diversion tunnel were installed during subsequent decades, it is unclear whether enough fish passed above the dam to sustain the run. The dam was partly removed in 1934, after which Redfish Lake runs partially rebounded. Evidence is mixed as to whether the restored runs constitute anadromous forms that managed to persist during the dam years, nonanadromous forms that became migratory, or fish that strayed in from outside the ESU.

4.1.12.5 Population Trends and Risks

NMFS proposed an interim recovery level of 2,000 adult Snake River sockeye salmon in Redfish Lake and two other lakes in the Snake River basin (Table 1.3-1 in NMFS 1995c). Low numbers of adult SR sockeye salmon preclude a CRI- or QAR-type quantitative analysis of the status of this ESU. Because only 16 wild and 264 hatchery-produced adult sockeye returned to the Stanley basin between 1990 and 2000, however, NMFS considers the status of this ESU to be dire under any criteria. Clearly the risk of extinction is very high.

4.2 SPECIES-LEVEL BIOLOGICAL REQUIREMENTS

The species-level biological requirements of the 12 listed ESUs are described in Section 1.3. NMFS has adopted the species-level biological requirements as its jeopardy standard.

4.3 SPECIES STATUS WITH RESPECT TO SPECIES-LEVEL BIOLOGICAL REQUIREMENTS

The current status of each species, as described in Section 4.1, indicates that the species-level biological requirements described in Section 1.3 are not being met for any of the 12 ESUs considered in this consultation. Improvements in survival rates (assessed over the entire life cycle) are necessary to meet species-level biological requirements in the future.
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5.0 ENVIRONMENTAL BASELINE

The purpose of this section is to identify "the past and present effects of all Federal, State, or private activities in the action area, the anticipated effects of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the effect of State or private actions which are contemporaneous with the consultation in process" (50 CFR § 402.02, definition of "effects of the action"). These factors affect the species' environment or critical habitat in the action area. The factors are described in relation to the action area biological requirements of the species.

5.1 DESCRIPTION OF ACTION AREA

The action area relative to both juvenile and adult Columbia basin salmonids is the part of their habitat that is affected by the FCRPS and other BOR project operations, as described in Section 1. The area is best defined as the farthest upstream point at which smolts enter (or adults exit) the Snake and upper Columbia rivers to the farthest downstream point at which they exit (or adults enter) the migration corridor. In the Snake River, the area translates to immediately below Hells Canyon Dam (or wherever a tributary stream meets the Snake River below Hells Canyon Dam) to the confluence of the Snake and Columbia rivers. In the Columbia River, the action area begins immediately below Chief Joseph Dam (or wherever a tributary stream meets the Columbia River below Chief Joseph Dam). Although the actual upstream extent of the action area varies among ESUs, in all cases the action area extends downstream to the farthest point (the Columbia River estuary and nearshore ocean environment) at which listed salmonids are influenced by FCRPS water management.

5.2 BIOLOGICAL REQUIREMENTS IN ACTION AREA

To some degree, each of the 12 ESUs considered in this opinion reside in, or migrate through, the action area. Biological requirements during these life history stages are obtained through access to essential features of critical habitat. Essential features include adequate 1) substrate (especially spawning gravel), 2) water quality, 3) water quantity, 4) water temperature, 5) water velocity, 6) cover/shelter, 7) food, 8) riparian vegetation, 9) space, and 10) migration conditions (58 FR 68546 for Snake River salmon and 65 FR 773 for all other Columbia River basin salmonids).

5.2.1 Essential Features of Critical Habitat in Action Area

The sections below describe essential features of critical habitat for each of the relevant habitat types: 1) juvenile rearing areas, 2) juvenile migration corridors, 3) areas for growth and development to adulthood, 4) adult migration corridors, and 5) spawning areas in the action area discussed in the following sections.

5.2.1.1 Juvenile Rearing Areas

Essential features of critical habitat for juvenile rearing areas include adequate water quality, water quantity, water velocity, cover/shelter, food, riparian vegetation, space, and safe passage conditions. The requirement for adequate substrate, although relevant to incubation of redds in the mainstem, is discussed under spawning areas, below.

5.2.1.2 Juvenile Migration Corridors

Essential features of critical habitat for juvenile migration corridors include adequate water quality, water quantity, water velocity, cover/shelter, food, riparian vegetation, space, and migration conditions.

5.2.1.3 Areas for Growth and Development to Adulthood

Essential features of critical habitat for areas for growth and development to adulthood include all the essential features of critical habitat for juvenile rearing areas (above).

5.2.1.4 Adult Migration Corridors

Essential features of critical habitat for adult migration corridors include all the essential features of critical habitat for juvenile migration corridors (above), except for adequate food.

5.2.1.5 Spawning Areas

Essential features of critical habitat for spawning areas include all the essential features of critical habitat for juvenile rearing areas (above), with the addition of adequate substrate and the exception of adequate food.

5.2.2 Adequacy of Habitat Conditions in Critical Habitat

Regulations implementing Section 7(a)(2) of the ESA define “destruction or adverse modification” as “a direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species.” Adverse effects on a constituent element of critical habitat generally do not result in a determination of “adverse modification” unless that loss, when added to the environmental baseline, is likely to result in an appreciable decline in the value of the critical habitat for both the survival and the recovery of the listed species (50 CFR Section 402.02).

Quantitatively defining a level of adequacy through specific, measurable standards is difficult for many of these biological requirements. In many cases, the absolute relationship between the critical element and species survival is not clearly understood, thus limiting development of specific, measurable standards. Some parameters are generally well known in the fisheries literature (e.g., thermal tolerances), allowing NMFS to develop a performance standard in this biological opinion (e.g., a temperature objective at Lower Granite Dam). For other action-area biological requirements, the effects of any adverse impacts on essential features of critical habitat are considered in more qualitative terms.

5.3 FACTORS AFFECTING SPECIES' ENVIRONMENT IN ACTION AREA

5.3.1 Hydrosystem Effects

Columbia River basin anadromous salmonids, especially those above Bonneville Dam, have been dramatically affected by the development and operation of the FCRPS. Storage dams have eliminated spawning and rearing habitat and have altered the natural hydrograph of the Snake and Columbia rivers, decreasing spring and summer flows and increasing fall and winter flows. Power operations cause flow levels and river elevations to fluctuate, affecting fish movement through reservoirs and riparian ecology, and stranding fish in shallow areas. The eight dams in the migration corridor of the Snake and Columbia rivers alter smolt and adult migrations. Smolts experience a high level of mortality passing through the dams. The dams also have converted the once-swift river into a series of slow-moving reservoirs, slowing the smolts' journey to the ocean and creating habitat for predators. Water velocities throughout the migration corridor now depend far more on volume runoff than before development of the mainstem reservoirs.

There have been numerous changes in the operation and configuration of the FCRPS as a result of ESA consultations between the Action Agencies (BPA, the Corps, and BOR) and the services (NMFS and USFWS). The changes have improved survival for the listed fish migrating through the Snake and Columbia rivers. Increased spill at all FCRPS dams allows smolts to avoid both turbine intakes and bypass systems. Increased flow in the mainstem Snake and Columbia rivers provides better inriver conditions for smolts. The transportation of smolts from the Snake River has also been improved by the addition of new barges and modification of existing barges.

In addition to spill, flow, and transportation improvements, the Corps implemented numerous other improvements to project operations and maintenance at all Columbia and Snake river dams. These improvements, such as operating turbines at peak efficiency, new extended-length screens at McNary, Little Goose, and Lower Granite dams, and extended operation of bypass screens, are discussed in greater detail in the 1995 FCRPS Biological Opinion.

It is possible to quantify the survival benefits accruing from these many actions for each of the listed ESUs. For SR spring/summer chinook smolts migrating inriver, the estimated direct survival through the hydrosystem is now between 40% and 60%, compared with an estimated survival rate during the 1970s of 5% to 40%. SR steelhead have probably received a similar benefit because their life history and run timing are similar to those of spring/summer chinook (NMFS 2000h). It is more difficult to obtain direct data and compare survival improvements for fish transported from the Snake River, but there are likely to be improvements for transported fish as well. It is reasonable to expect that the improvements in operation and configuration of the FCRPS will benefit all listed Columbia basin salmonids and that the benefits will be greater the farther upriver the ESU. However, further improvements are necessary because the Federal hydrosystem continues to cause a significant level of mortality for some ESUs.

Several non-Federal projects licensed by the Federal Energy Regulating Commission (FERC) also affect the 12 ESUs on the mainstem Columbia and Snake rivers. Many of the ESUs are also affected by FERC projects on smaller tributaries or other water development projects.

5.3.2 Habitat Effects

The quality and quantity of freshwater habitat in much of the Columbia River basin have declined dramatically in the last 150 years. Forestry, farming, grazing, road construction, hydrosystem development, mining, and urbanization have radically changed the historical habitat conditions of the basin. With the exception of fall chinook, which generally spawn and rear in the mainstem, salmon and steelhead spawning and rearing habitat is found in tributaries to the Columbia and Snake rivers. Anadromous fish typically spend from a few months to 3 years rearing in freshwater tributaries. Depending on the species, they spend from a few days to 1 or 2 years in the Columbia River estuary before migrating out to the ocean and another 1 to 4 years in the ocean before returning as adults to spawn in their natal streams. Thirty-two subbasins provide spawning and rearing habitat.

Water quality in streams throughout the Columbia River basin has been degraded by human activities such as dams and diversion structures, water withdrawals, farming and grazing, road construction, timber harvest activities, mining activities, and urbanization. Over 2,500 streams and river segments and lakes do not meet Federally approved, state and Tribal water quality standards and are now listed as water-quality-limited under Section 303(d) of the CWA. Tributary water quality problems contribute to poor water quality where sediment and contaminants from the tributaries settle in mainstem reaches and the estuary.

Most of the water bodies in Oregon, Washington, and Idaho that are on the 303(d) list do not meet water quality standards for temperature. Temperature alterations affect salmonid metabolism, growth rate, and disease resistance, as well as the timing of adult migrations, fry emergence, and smoltification. Many factors can cause high stream temperatures, but they are primarily related to land-use practices rather than point-source discharges. Some common actions that result in high stream temperatures are the removal of trees or shrubs that directly shade streams, excessive water withdrawals for irrigation or other purposes, and warm irrigation return flows. Loss of wetlands and increases in groundwater withdrawals have contributed to lower base-stream flows, which in turn contribute to temperature increases. Channel widening and land uses that create shallower streams also cause temperature increases.

Pollutants also degrade water quality. Salmon require clean gravel for successful spawning, egg incubation, and emergence of fry. Fine sediments clog the spaces between gravel and restrict the flow of oxygen-rich water to the incubating eggs. Excess nutrients, low levels of dissolved oxygen, heavy metals, and changes in pH also directly affect the water quality for salmon and steelhead.

Water quantity problems are also a significant cause of habitat degradation and reduced fish production. Millions of acres of land in the basin are irrigated. Although some of the water withdrawn from streams eventually returns as agricultural runoff or groundwater recharge, crops consume a large proportion. Withdrawals affect seasonal flow patterns by removing water from streams in the summer (mostly May through September) and restoring it to surface streams and groundwater in ways that are difficult to measure. Withdrawing water for irrigation, urban, and other uses can increase temperatures, smolt travel time, and sedimentation. Return water from irrigated fields can introduce nutrients and pesticides into streams and rivers.

On a larger landscape scale, human activities have affected the timing and amount of peak water runoff from rain and snowmelt. Forest and range management practices have changed vegetation types and density, which can affect timing and duration of runoff. Many riparian areas, flood plains, and wetlands that once stored water during periods of high runoff have been developed. Urbanization paves over or compacts soil and increases the amount and pattern of runoff reaching rivers and streams.

Many tributaries have been significantly depleted by water diversions. In 1993, fish and wildlife agency, Tribal, and conservation group experts estimated that 80% of 153 Oregon tributaries had low-flow problems (two-thirds caused at least in part by irrigation withdrawals) (OWRD 1993). The NWPPC showed similar problems in many Idaho, Oregon, and Washington tributaries (NWPPC 1992).

Blockages that stop the downstream and upstream movement of fish exist at many agricultural, hydrosystem, municipal/industrial, and flood control dams and barriers. Highway culverts that are not designed for fish passage also block upstream migration. Migrating fish are diverted into unscreened or inadequately screened water conveyances or turbines, resulting in unnecessary mortality. While many fish-passage improvements have been made in recent years, manmade structures continue to block migrations or kill fish throughout the basin.

Land ownership has played a part in habitat and land-use changes. Federal lands, which compose 50% of the basin, are generally forested and influence upstream portions of the watersheds. While there is substantial habitat degradation across all ownerships, in general, habitat in many headwater stream sections is in better condition than in the largely non-Federal lower portions of tributaries (Doppelt et al. 1993, Frissell 1993, Henjum et al. 1994, Quigley and Arbelbide 1997). In the past, valley bottoms were among the most productive fish habitats in the basin (Stanford and Ward 1992, Spence et al. 1996, ISG 1996). Today, agricultural and urban land development and water withdrawals have significantly altered the habitat for fish and wildlife. Streams in these areas typically have high water temperatures, sedimentation problems, low flows, simplified stream channels, and reduced riparian vegetation.

Mainstem habitats of the Columbia, Snake, and Willamette rivers have been affected by impoundments that have inundated large amounts of spawning and rearing habitat. Historically, fall chinook salmon spawned in the mainstem near The Dalles, Oregon, upstream to the Pend Oreille River in Washington and the Kootenai River in Idaho, in the Snake River downstream of Shoshone Falls, and upstream from the mouth of the Snake River to Grand Coulee Dam. Current mainstem production areas for fall chinook are mostly confined to the Hanford Reach of the mid-Columbia River and to the Hells Canyon Reach of the Snake River, with minor spawning populations elsewhere in the mid-Columbia, below the lower Snake River dams, and below Bonneville Dam. Hanford Reach is the only known mainstem spawning area for steelhead. Chum salmon habitat in the lower Columbia may also have been inundated by Bonneville Reservoir. Mainstem habitat in the Columbia, Snake, and Willamette rivers has been reduced, for the most part, to a single channel, floodplains have been reduced in size, off-channel habitat features have been lost or disconnected from the main channel, and the amount of large woody debris (large snags/log structures) in rivers has been reduced. Most of the remaining habitats are affected by flow fluctuations associated with reservoir management.

The Columbia River estuary has also been changed by human activities. Historically, the downstream half of the estuary was a dynamic environment with multiple channels, extensive wetlands, sandbars, and shallow areas. The mouth of the Columbia River was about 4 miles wide. Winter and spring floods, low flows in late summer, large woody debris floating downstream, and a shallow bar at the mouth of the Columbia River kept the environment dynamic. Today, navigation channels have been dredged, deepened and maintained, jetties and pile-dike fields have been constructed to stabilize and concentrate flow in navigation channels, marsh and riparian habitats have been filled and diked, and causeways have been constructed across waterways. These actions have decreased the width of the mouth of the Columbia River to 2 miles and increased the depth of the Columbia River channel at the bar from less than 20 to more than 55 feet. Sand deposition at river mouths has extended the Oregon coastline approximately 4 miles seaward and the Washington coastline approximately 2 miles seaward (Thomas 1981).

More than 50% of the original marshes and spruce swamps in the estuary have been converted to industrial, transportation, recreational, agricultural, or urban uses. More than 3,000 acres of intertidal marsh and spruce swamps have been converted to other uses since 1948 (Lower Columbia River Estuary Program [LCREP] 1999). Many wetlands along the shore in the upper reaches of the estuary have been converted to industrial and agricultural lands after levees and dikes were constructed. Furthermore, water storage and release patterns from reservoirs upstream of the estuary have changed the seasonal pattern and volume of discharge. The peaks of spring/summer floods have been reduced, and the amount of water discharged during winter has increased.

Studies begun in 1997 by the Oregon Cooperative Fish and Wildlife Research Unit, USGS, and CRITFC have shown that fish-eating birds that nest on islands in the Columbia River estuary (Caspian terns, double-crested cormorants, and glaucous-winged gulls) are significant avian predators of juvenile salmonids. Researchers estimated that the tern population on Rice Island (16,000 birds in 1997) consumed 6 to 25 million outmigrating smolts during 1997 (Roby et al. 1998) and 7 to 15 million outmigrating smolts during 1998 (Collis et al. 1999). The observed levels of predation prompted the regional fish and wildlife managers to investigate the feasibility of management actions to reduce the impacts. Early management actions appear to have reduced predation rates; researchers estimate that terns consumed 7.3 million smolts during 1999 (Columbia Bird Research 2000). Because Rice Island is a dredged material disposal site in the Columbia River estuary, created by the Corps under its Columbia River Channel Operation and Maintenance Program, the effects of tern predation on the survival and recovery of listed salmonids are considered in a separate consultation on that program. This factor is considered part of the environmental baseline on effects of the FCRPS.

The Basinwide Recovery Strategy outlines a broad range of current habitat programs. Because most of the basin's anadromous fish spawning habitat is in Federal ownership, Federal land management programs are of primary importance. Current management is governed by an ecosystem-based aquatic habitat and riparian-area management strategy known as PACFISH and associated biological opinions. This interim strategy covers the majority of the basin accessible to anadromous fish and includes specific prescriptions designed to halt habitat degradation.

The Basinwide Recovery Strategy also outlines a large number of non-Federal habitat programs. Because non-Federal habitat is managed predominantly for private rather than public purposes, however, expectations for non-Federal habitat are harder to assess. Degradation of habitat for listed fish from activities on non-Federal lands is likely to continue to some degree over the next 10 years, although at a reduced rate due to state, Tribal, and local recovery plans.

5.3.3 Hatchery Effects

For more than 100 years, hatcheries in the Pacific Northwest have been used to replace natural production lost as a result of the FCRPS and other development, not to protect and rebuild natural populations. As a result, most salmon populations in this region are primarily hatchery fish. In 1987, for example, 95% of the coho, 70% of the spring chinook, 80% of the summer chinook, 50% of the fall chinook, and 70% of the steelhead returning to the Columbia basin originated in hatcheries (CBFWA 1990).

While hatcheries certainly have contributed greatly to the overall numbers of salmon, only recently has the effect of hatcheries on native wild populations been demonstrated. In many cases, these effects have been substantial. For example, production of hatchery fish, among other factors, has contributed to the 90% reduction in wild coho salmon runs in the lower Columbia River over the past 30 years (Flagg et al. 1995). Hatcheries have traditionally focused on providing fish for harvest, with less attention given to identifying and resolving factors causing declines of native runs.

NMFS has identified four primary categories of risk that hatcheries can pose on wild-run salmon and steelhead: 1) ecological effects, 2) genetic effects, 3) overharvest effects, and 4) masking effects (NMFS 2000g). Ecologically, hatchery fish can increase predation on, displace, and/or compete with wild fish. These effects are likely to occur when fish are released in poor condition and do not migrate to marine waters, but rather remain in the streams for extended rearing periods during which they may prey on or compete with wild fish. Hatchery fish also may transmit hatchery-borne diseases, and hatcheries themselves may release diseases into streams via water effluents.

Genetically, hatchery fish can affect the genetic variability of native fish via interbreeding, either intentionally or accidentally. Interbreeding can also result from the introduction of native stocks from other areas. Theoretically, interbred fish are less adapted to and productive within the unique local habitats where the original native stock evolved.

In many areas, hatchery fish provide increased fishery opportunities. When wild fish mix with hatchery stock, fishing pressure can lead to overharvest of smaller or weaker wild stocks. Further, when migrating adult hatchery and wild fish mix on the spawning grounds, the health of the wild runs and the condition of the habitat's ability to support runs can be overestimated, because the hatchery fish mask surveyors' ability to discern actual wild run conditions.

The role of hatcheries in the future of Pacific Northwest salmon and steelhead is presently unclear; it will depend on the values people place on fish production and biological diversity. Clearly, conservation of biological diversity is gaining support, and the future role of hatcheries may shift toward judicial use of hatcheries to meet these goals rather than opposing them. One of the prime recommendations in the National Research Council's (NRC's) study of salmon in the Pacific Northwest is that hatchery use "should occur within the context of fully implemented adaptive-management programs that focus on watershed management, not just on the fish themselves" (NRC, 1996). A recent review of this approach for the Columbia basin can be found in ISAB (1998).

5.3.4 Harvest Effects

The history of harvest of Columbia River basin salmon parallels that of the entire region. Commercial fishing developed rapidly with the arrival of European settlers and the advent of canning technologies in the late 1800s. Development of non-Indian fisheries began in about 1830; by 1861, commercial fishing was an important economic activity. The early commercial fishery used gill nets, seines hauled from shore, traps, and fish wheels. Later, purse seines and trolling (using hook and line) fisheries developed. Recreational (sport fishing) began in the late 1800s, occurring primarily in tributary locations (ODFW and WDFW 1998).

Initially, the non-Indian fisheries targeted spring and summer chinook salmon, and these runs dominated the commercial harvest during the 1800s. Eventually the combined ocean and freshwater harvest rates for Columbia River spring and summer chinook exceeded 80% and sometimes 90% of the run, contributing to the species' decline (Ricker 1959). From 1938 to 1955, the average harvest rate dropped to about 60% of the total spring chinook salmon run and appeared to have a minimal effect on subsequent returns (NMFS 1991b). Until the spring of 2000, when a relatively large run of hatchery spring chinook returned and provided a small commercial Tribal fishery, the last commercial season for spring chinook had occurred in 1977. Present Columbia River harvest rates are very low compared with those from the late 1930s through the 1960s (NMFS 1991b).

The summer chinook salmon run could not sustain the average harvest rate of 88% that was applied between 1938 to 1944 and produced lower returns between 1942 and 1949 (NMFS 1991b). From 1945 through 1949, the Columbia River harvest rate on summer chinook salmon was reduced to about 47%, and subsequently, the run size increased. Construction of Grand Coulee Dam in 1941, with the resulting inundation of summer chinook spawning areas, was a primary factor influencing this species' declining abundance. In the 1950s and 1960s, harvest rates further declined to about 20% (Raymond 1988). This species has not been the target of any commercial harvest since 1963.

Following the sharp declines in spring and summer chinook in the late 1800s, fall chinook salmon became a more important component of the catch. Fall chinook have provided the greatest contribution to Columbia River salmon catches in most years since 1890. Through the first part of this century, the commercial catch was usually canned for marketing. The peak year of commercial sales was 1911, when 49.5 million pounds of fall chinook were landed. Columbia River chinook salmon catches were generally stable from the beginning of commercial exploitation until the late 1940s, when landings declined by about two-thirds to a level that remained stable from the 1950s through the mid-1980s (ODFW and WDFW 1998). Since 1938, total salmonid landings (all species) have ranged from a high of about 2,112,500 fish in 1941 to a low of about 68,000 fish in 1995 (Figure A.1 in ODFW and WDFW 1998).

Whereas freshwater fisheries in the basin were declining during the first half of this century, ocean fisheries were growing, particularly after World War II. This trend occurred up and down the West Coast as fisheries with new gear types leapfrogged over the others to gain first access to the migrating salmon runs. Large, mixed-stock fisheries in the ocean gradually supplanted the freshwater fisheries, which were increasingly restricted or eliminated to protect spawning escapements. By 1949, the only freshwater commercial gear types remaining were gill nets, dip nets, and hoop nets (ODFW and WDFW 1998). This leapfrogging by various fisheries and gear types resulted in conflicts about harvest allocation and the displacement of one fishery by another. Ocean trolling peaked in the 1950s; recreational fishing peaked in the 1970s. The ocean harvest has declined since the early 1980s as a result of declining fish populations and increased harvest restrictions (ODFW and WDFW 1998).

The construction of The Dalles Dam in 1957 had a major effect on Tribal fisheries. The Dalles Reservoir flooded Celilo Falls and inundated the site of a major Indian fishery that had existed for millennia. Commercial Indian landings at Celilo Falls from 1938 through 1956 ranged from

0.8 to 3.5 million pounds annually, based primarily on dip netting (ODFW and WDFW 1998). With the elimination of Celilo Falls, salmon harvest in the area declined dramatically. In 1957, in a joint action, the states of Oregon and Washington closed the Tribal fishery above Bonneville Dam to commercial harvesters. Treaty Indian fisheries that continued during 1957 through 1968 were conducted under Tribal ordinances. In 1968, with the Supreme Court opinion on the appeal of the *Puyallup v. Washington* case, the states reopened the area to commercial fishing by treaty Indians (ODFW and WDFW 1998). For the next 6 years, until 1974, only a limited Tribal harvest occurred above Bonneville Dam. By then, the Tribal fishery had developed an alternative method of setting gill nets that was suitable for catching salmon in the reservoirs (ODFW and WDFW 1998).

The capacity of salmonids to produce more adults than are needed for spawning offers the potential for sustainable harvest of naturally produced (versus hatchery-produced) fish. This potential can be realized only if two basic management requirements are met: 1) enough adults return to spawn and perpetuate the run, and 2) the productive capacity of the habitat is maintained. Catches may fluctuate in response to such variables as ocean productivity cycles, periods of drought, and natural disturbance events. However, as long as the two management requirements are met, fishing can be sustained indefinitely. Unfortunately, both prerequisites for sustainable harvest have been violated routinely in the past. The lack of coordinated management across jurisdictions, combined with competitive economic pressures to increase catches or to sustain them in periods of lower production, resulted in harvests that were too high and escapements that were too low. At the same time, habitat has been increasingly degraded, reducing the capacity of the salmon stocks to produce numbers in excess of their spawning escapement requirements.

For years, the response to declining catches was hatchery construction to produce more fish. Because hatcheries require fewer adults to sustain their production, harvest rates in the fisheries were allowed to remain high, or even increase, further exacerbating the effects of overfishing on the naturally produced (nonhatchery) runs mixed in the same fisheries. More recently, harvest managers have instituted reforms including weak stock, abundance-based, harvest rate, and escapement-goal management.

5.3.5 Natural Conditions

Changes in the abundance of salmonid populations are substantially affected by changes in the freshwater and marine environments. For example, large-scale climatic regimes, such as El Niño, affect changes in ocean productivity. Much of the Pacific Coast was subject to a series of very dry years during the first part of the 1990s. In more recent years, severe flooding has adversely affected some stocks. For example, the low return of Lewis River bright fall chinook salmon in 1999 is attributed to flood events during 1995 and 1996.

Salmon and steelhead are exposed to high rates of natural predation, particularly during freshwater rearing and migration stages. Ocean predation may also contribute to significant natural mortality, although the levels of predation are largely unknown. In general, salmonids are prey for pelagic fishes, birds, and marine mammals, including harbor seals, sea lions, and killer whales. There have been recent concerns that the rebound of seal and sea lion populations, following their protection under the Marine Mammal Protection Act of 1972, has resulted in substantial mortality for salmonids. In recent years, for example, sea lions have learned to target UWR spring chinook salmon in the fish ladder at Willamette Falls.

A key factor substantially affecting many West Coast stocks has been the general pattern of a 30-year decline in ocean productivity. The mechanism whereby stocks are affected is not well understood. The pattern of response to these changing ocean conditions has differed among stocks, presumably due to differences in their ocean timing and distribution. It is presumed that survival is driven largely by events occurring between ocean entry and recruitment to a subadult life stage. One indicator of early ocean survival can be computed as a ratio of CWT recoveries of subadults relative to the number of CWTs released from that brood year. Time-series of survival rate information for UWR spring chinook, Lewis River fall chinook, and Skagit fall chinook salmon show highly variable or declining trends in early ocean survival, with very low survival rates in recent years (NMFS 1999c).

Recent evidence suggests that marine survival of salmonids fluctuates in response to 20- to 30-year cycles of climatic conditions and ocean productivity (Cramer et al. 1999). This phenomenon has been referred to as the Pacific Decadal Oscillation (PDO). Ocean conditions that affect the productivity of Northwest salmonid populations appear to have been in a low phase of the cycle for some time and to have been an important contributor to the decline of many stocks. The survival and recovery of these species will depend on their ability to persist through periods of low natural survival.

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